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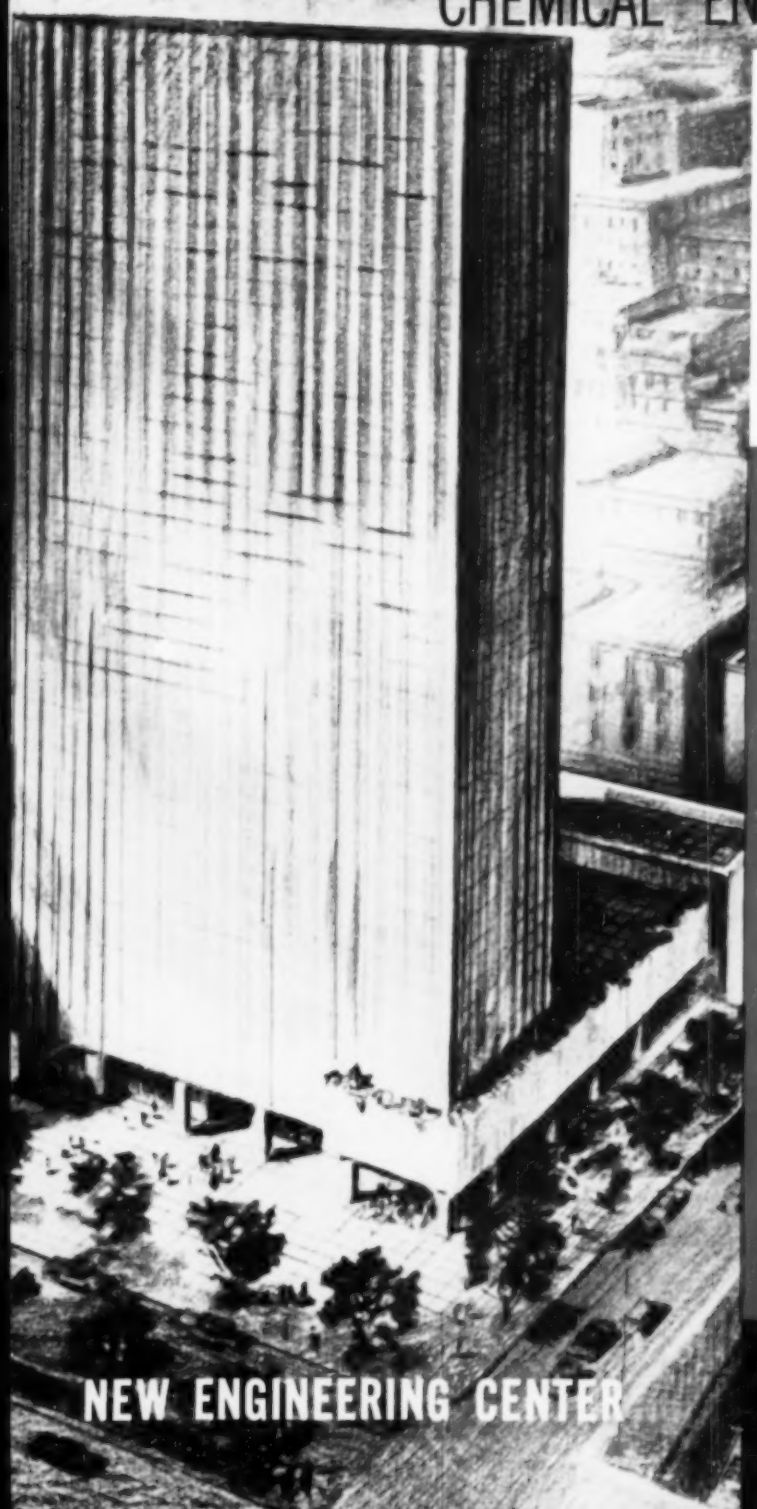

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EYEWITNESS REPORT on Soviet technology by American chemical engineering educator . . .

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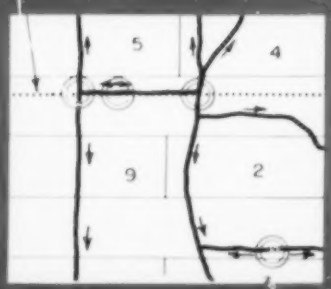

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what's in this issue

December, 1957 • Volume 53, No. 12

Too little basic research / 8
Noted & Quoted—Industrial research executive Mervin J. Kelly analyzes our needs, concludes industry could do more.

Financial incentives; shortage; community activities / 14
Letters to the Editor—Recent article by DeHaven (*CEP*—October) draws striking comments; chemical engineer scores victory in recent elections.

A chemical engineer visits Russia / 19
Edgar L. Piret—A thought-provoking illustrated report based on observations by a skilled observer of chemical engineering activities, made during his recent visit to the Soviet Union as a member of an official mission.

What to do about that hazard / 28
Marginal Notes—A newly rewritten handbook on dangerous materials has been issued.

Cross-currents / 45
Trends—Implications of increased defense spending for American industry are seen as influencing present business picture.

CEP SPECIAL CO-FEATURE

Post-explosion detonation analysis: new tool for the safety of the chemical process plant

Destruction of a large refining unit by gaseous detonation / 565
R. B. Jacobs, W. L. Bulkley, J. C. Rhodes, and T. L. Speer—First report on technical aspects of the detonation which destroyed a large industrial process unit.

Effects of gaseous detonations upon vessels and piping / 574
P. N. Randall, J. Bland, W. M. Dudley, and R. B. Jacobs—Studies made in connection with the explosion of the refinery unit, including development of principles involved in rupturing of pipes and vessels by gaseous detonation and discussion of engineering and metallurgical information pertinent to the explosion.

Estimating direct operating labor for new processes / 581
R. S. Wolbus—An account of the simplified methods in current use in various organizations.

CEP SPECIAL CO-FEATURE

Highlights of recent developments in Drying and Calcining

Development of an agitated trough continuous calciner / 586
M. J. Szulinski—The consecutive stages of development

(Continued on page 5)

departmental features

Noted and quoted / 8 • Letters to the editor / 14 • Marginal notes / 28
About our authors / 32 • Opinion and comment / 563 • Data service / 55
Future meetings / 96 • News from local sections / 102 • CEP camera / 114
Candidates for membership / 116 • People / 118 • Classified / 126
News and notes of A.I.Ch.E. / 130

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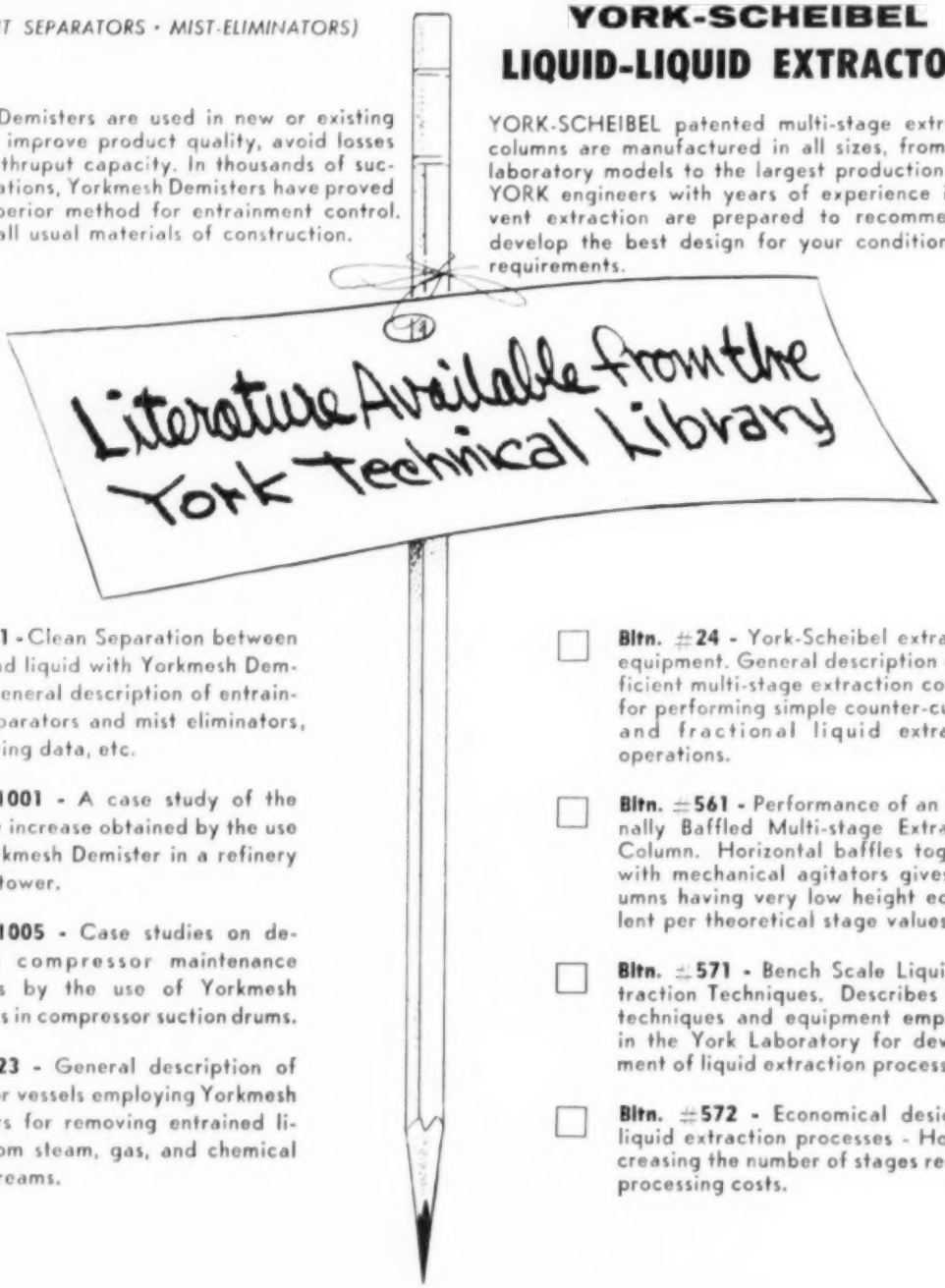

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(Continued from page 3)

of a device which ultimately gave superior results in the calcining of a molten salt.

Drying of viable biologicals with organic solvents / 590

R. R. Freeman, T. R. Dashiell, M. A. Auro, I. Osborne, and R. F. Smith—Processes amenable to continuous operation employ solvent extraction and azeotropic distillation.

The spray drying of detergents / 593

J. H. Chaloud, J. B. Martin, and J. S. Baker—Results of a study of the basic principles of spray drying give a better understanding of the mechanisms involved.

Improved heat transfer system for freeze drying / 597

I. M. Abelow and E. W. Flosdorf—An equipment development report, covering experiments and tests which evolved tray design and other factors offering improved operation.

CEP SPECIAL CO-FEATURE

Sorption Processes—Part II

Granular processes—ion exchange / 601

W. A. Selke—A review of significant developments representative of the growth of application of granular ion exchange techniques.

Membrane processes—ion exchange / 606

A. G. Winger—Ion exchange membranes continue to hold promise of economically accomplishing difficult separations. Here is a review of significant contributions to the status of the mechanism theory and applications.

What's in S.S. Volume / 612

Contents of Vol. 53, No. 20, 1957, Symposium Series, *Liquid Metals Technology, Pt. I.*

CEP 1957 Annual Index / i-viii

What's doing in industry? / 48, 52

Industrial News—Steel mill installs coke-byproducts refinery . . . largest boron source opened . . . Celanese's acrylate . . . sampling of current management thinking on chemical industry problems.

Saline water developments / 68

J. Gillman—Progress report based on recent meeting.

United engineering center plans fund raising drive / 74

With a ceremony led by Herbert Hoover, the national fund raising drive—to net $3 million from societies' members—gets under way.

Washington Feedback / 82

The American people's growing interest in strengthening our scientific and technological position in the world offers a new challenge to the professions.

AEC to process spent fuels / 90

The Commission's announcement, and explanation of the results of surveying the interests of private industry.

Golden jubilee of chemical engineering / 110

Planning progress report on the A.I.Ch.E. Fiftieth Anniversary meeting in Philadelphia next June.

Chemical engineering abroad / 113

The experiences of a major chemical industry construction firm in building a South African plant underline the importance of the human aspects of engineering.

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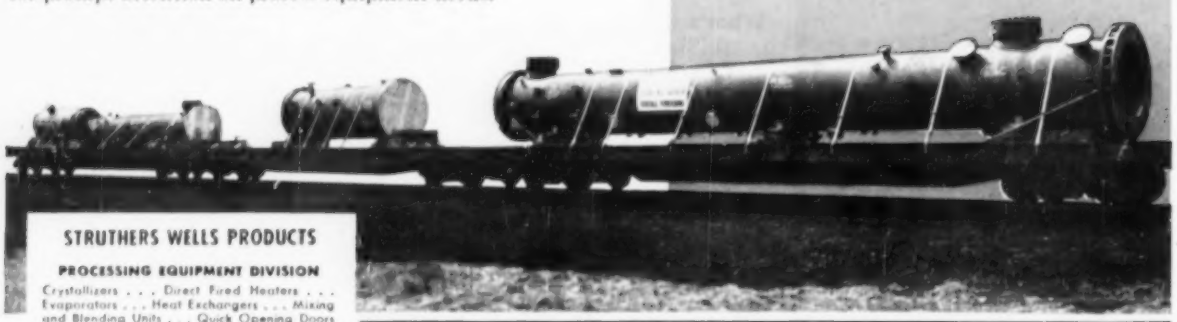

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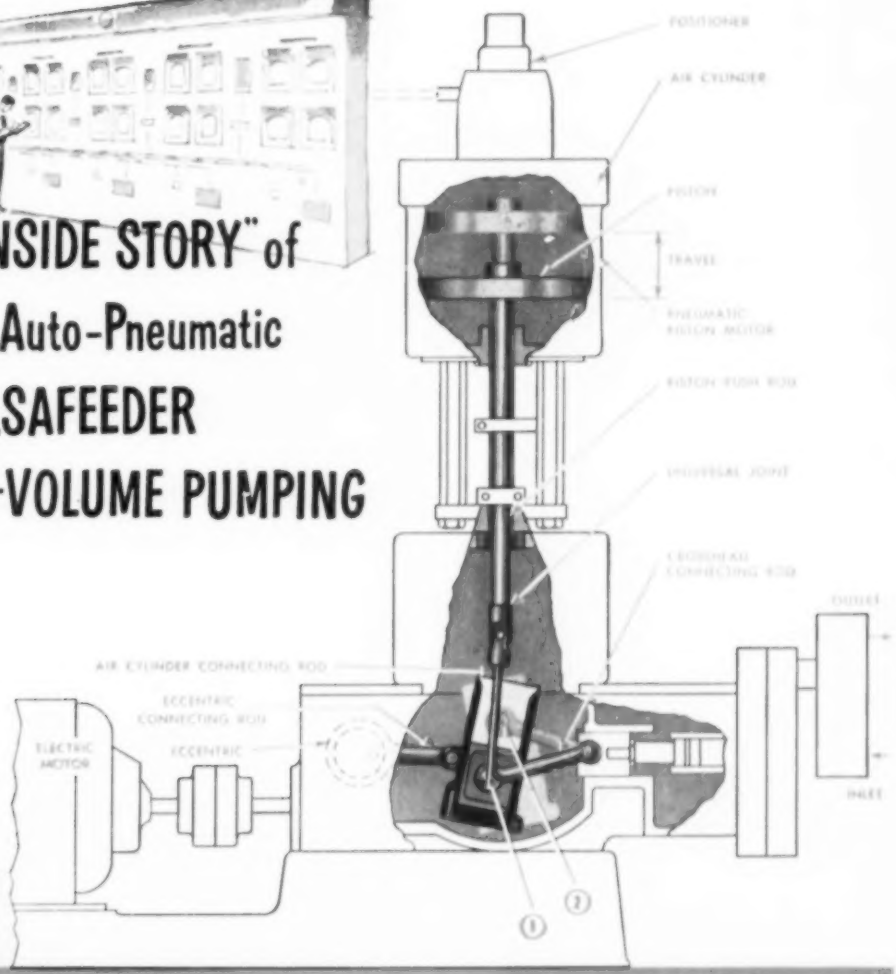

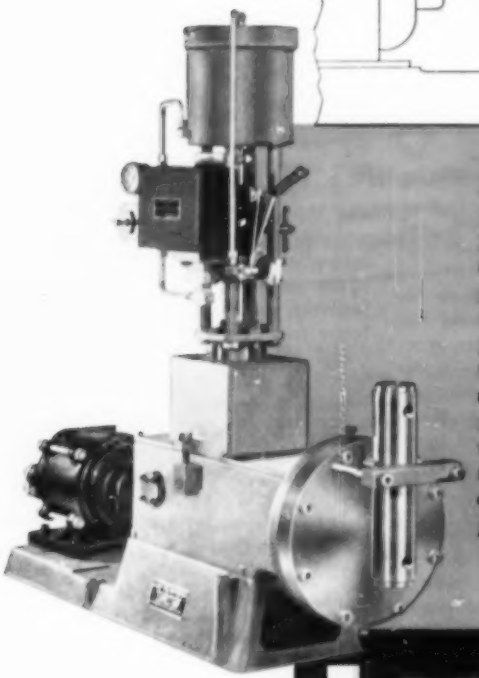

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TOO LITTLE BASIC RESEARCH

Mervin J. Kelly

President Bell Telephone Laboratories, Inc., New York, New York

The volume of our basic research is too low and its fraction of the nation's research and development is too small. Not more than 5 per cent of the $7 billion expended in 1956 was for basic research. Professor Glenn Seaborg recently stated that at least twice that percentage could well be spent. With this I am in complete agreement. Basic research provides the knowledge that paces progress in providing new facilities and services for our society and in increasing the nation's strength. Money spent for basic research is one of the nation's best investments; too little and too late could be of tragic consequence.

Most of the basic research is done in our academic institutions and private foundations. The university is traditionally the home of basic research. It provides the environment and freedoms essential for research to thrive. It must continue as the primary source of new scientific knowledge. Industry, the principal converter of new scientific knowledge into facilities and services for our society, in its own interest as well as in that of the nation, must make much larger contributions to basic research.

In the postwar years, basic research in the universities has expanded greatly. Its rate of growth should be increased. Further expansion, however, is limited by lack of funds. These funds must be sharply increased. If the recent rate of growth is to be maintained, faculties must be enlarged, new space provided, and operating funds increased.

A typical example of inadequacy of funds, and in a most important area, is that of atomic nuclear research. In the years since 1940, our nation has made the largest contribution to new knowledge of the nucleus; but we yet have a long way to go. Continuing progress in nuclear structure research demands particle accelerators more powerful than any we now have available. A recent study for the National Science Foundation by a committee of distinguished physicists stresses the limitations of present particle accelerators and recommends the prompt construction of several accelerators of higher energy. The cost of construction and operation of these accelerators is very large. The nation is now expending some $40 million annually on research employing the high energy accelerators. The committee recommends that this be increased to $60 to $80 million annually in the next five years.

The high energy physics that these accelerators implement is at this time the most challenging activity in science, both with respect to its technology and its central importance to basic science. The number of high energy accelerator installations in Soviet Russia has increased significantly in recent years. Although our nation is now leading in the number and diversity of its accelerators and in the pro-

(Continued on page 10)

Excerpted from "The Nation's Research and Development, Their Deficiencies and Means for Correction," *Proc. Am. Phil. Soc.* (August, 1957).

MORE PUSH-BUTTONS, MORE ENGINEERS

Willis M. Cooper

**Assistant General Manager
Research and Engineering Department
Monsanto Chemical Co., St. Louis, Missouri**

One of the most pressing problems facing the chemical industry, the United States, and the world as a whole, is the existing and growing shortage of technically trained people. The shortage is felt more strongly, at least by numbers, in the field of engineering, since each major technological development in a field changes engineering requirements by an order of magnitude. For example, the fighter aircraft of World War II required approximately 250 man-months for design. By the time of the Korean War, this figure had risen to 6,700, and now it is in the neighborhood of 28,000 man-months.

Much has been written on this subject, and it is not profitable to rehash the old information. It is pertinent to comment on the commonly held belief that the advent of push-button operation and electronic computers may reduce the requirements for trained engineers. The situation is exactly to the contrary—the requirement for engineers will increase even more rapidly.

In the chemical and petroleum industries where automatic control has been carried farther than other process industries, there has been a decrease in the number of production worker hours per unit product. However, this has been accompanied by an increase in the skills and earnings of production workers, an increase in the number of maintenance workers (especially in highly skilled classifications), and an increase in the number of engineers required to design the increasingly complex and interlocked plants.

The engineering required to produce plants of this type is several orders of magnitude greater than for a standard assembly-line operation with men as the controllers for power tools. The analogy with aircraft design should be fairly direct, since the modern aircraft is a truly designed system, in which such functions as gunfire control, navigation, and instrument coordination are provided for a pilot who makes only important command decisions.

Most engineering groups have found that the computer, as such, is not a replacement for engineers. Instead of saving engineering time, it allows us to use more engineering time more effectively, to produce a considerably better result. Thus, we are able to use complicated calculation techniques which have been ruled out in the past because of the time required to carry them out. Further, we are able to make many calculations, on a fundamental basis, to determine an optimum design, in the place of a single choice based on rules-of-thumb and short-cut methods with many simplified assumptions.

The "push-button" age will not be the age when machines replace engineers, but rather the one in which more engineers, using machines, will be able to design plants in which the operators are thinking men, making decisions.

Excerpted from Fall, 1957, *Monsanto Chemical Review*.

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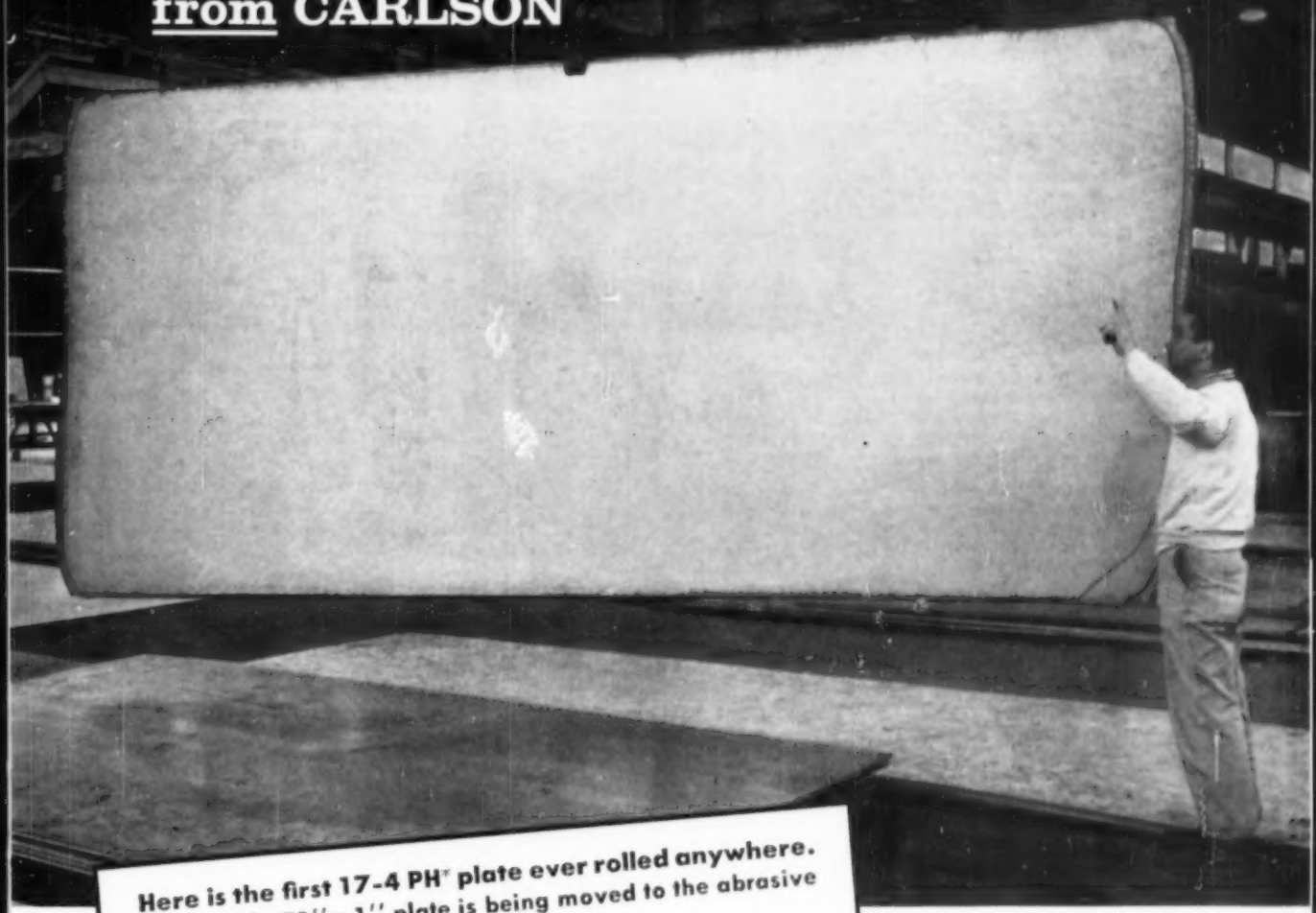

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(Continued from page 8)

ductivity of its research programs, the rate of Soviet progress has been such that this situation may well not persist through the next decade.

The apparently unlimited government support by the Soviet, and the high rate of production of well-qualified scientists and engineers present a challenging situation. Unless our scientists are promptly provided with the facilities and funds for their operation, the loss of our number one position in high energy physics seems inevitable.

I have presented this situation as it is typical of many others that are developing. Russia appears determined to surpass us in science and technology and is committing large resources to that end, well in excess of our commitments, and has coupled this with an educational development program for scientists and engineers larger and more effective than ours.

Less than 20 per cent of the nation's basic research is done in industry's laboratories, and this is highly concentrated in a few of them. Seventy per cent of the nation's research and development is done by industry, but less than 2 per cent of this effort is in basic research. This statement of industry's small basic research contribution may be questioned. It is supported, however, by the relative volume of basic research reports by industry at meetings of our scientific societies. Of the 450 papers presented at a recent meeting of the Physical Society, only 46 came from industry and more than half of these were from five laboratories. The data of this meeting are typical.

Industry is the potential source of basic research contributions many fold greater than its present volume. A few of industry's laboratories of greatest maturity have amply demonstrated that industry can maintain the environment and freedoms essential for productivity in basic research by its scientists.

As the director of one of these laboratories, I know that basic research is of great value to the company and to the nation. For the company, it makes possible early invention in new areas of science. It can add great strength to the applied research and development activities of the company. In fact, those large laboratories that do not conduct basic research in an amount in balance with their applied research and development, will not attain the highest possible level of productivity for their applied activities. For the nation, it adds to the total reservoir of its new scientific knowledge and provides more effective laboratories for the development of facilities for the military.

(Continued on page 12)

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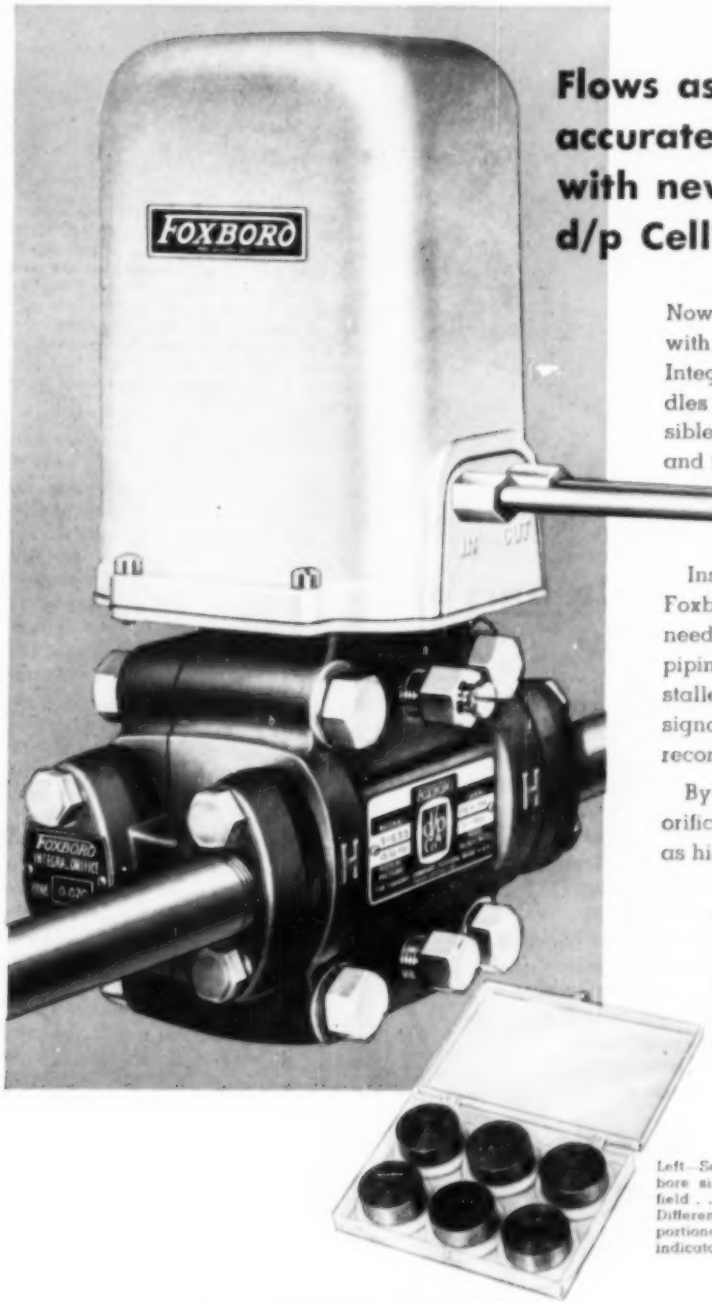

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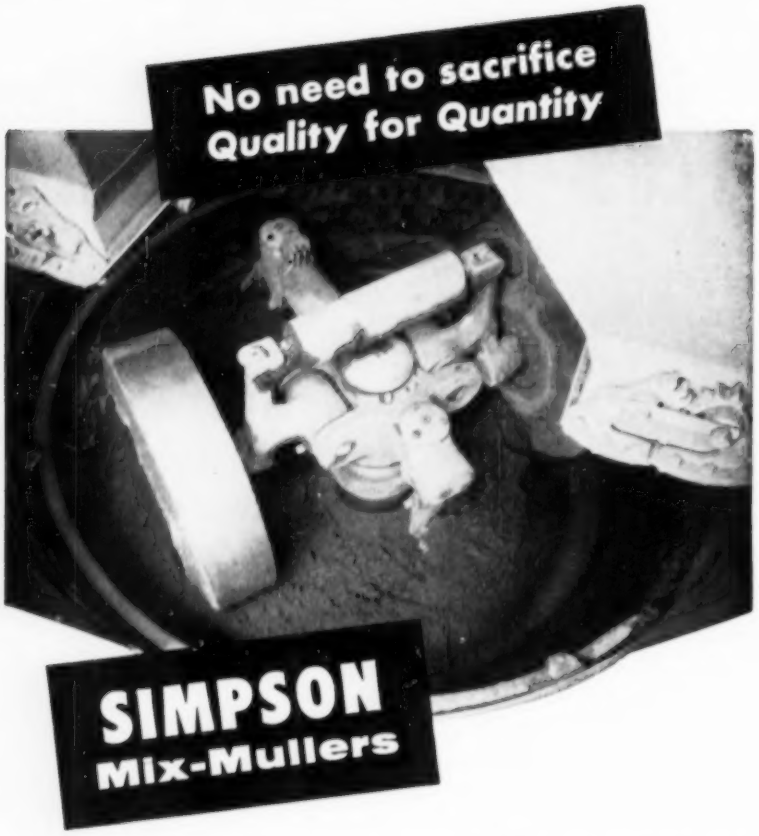

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Noted and quoted

(*Continued from page* 10)

Basic research is a long range undertaking; through it a company is investing in its future. At least five and often ten years elapse before the new knowledge from basic research is translated into industrial products. However, after the initial period, a new basic research organization of adequate size will provide a continuous flow of new knowledge of great value to the company.

Large resources, patience, and a management with professional understanding are absolutely necessary for success.

At least one hundred of our industrial companies have adequate resources and broad enough technologic interests to support significant programs in basic research; yet not more than twenty companies are now doing so. Why is the number so small? There is a complex of reasons. The more important ones are the immaturity of industrial research laboratories and the nation's lack of basic scientists with management experience in industry.

Industrial research is scarcely fifty years old in our country and most of industry's laboratories are not yet twenty years of age. We are, therefore, suffering from immaturity. The scientific and technologic activity, from basic research to design of products, is one of the most complex of the professional activities of our society. It is my judgment that only one who is deeply trained in science and has basic research experience can have the perspective to organize and develop programs extending from basic research through the succeeding technologic steps for an industry. Too many of industry's technologic leaders, while most able men, are engineers and not deeply trained in science nor with basic research experience. If one examines the technical leadership of the nation's successful large industrial companies with laboratories of forty to fifty years of age, he will find a continuity of leaders who are scientists possessing basic research experience.

For building basic research into industry and improving the effectiveness of manpower usage, our greatest need is for professional leadership adequate to encompass the entire scientific and technologic range of research and development. Such leadership can obtain management's support of basic research and can lead in the building of staff, patterns of organization, and environment so essential to balanced success in all sectors of research and development—basic research, applied research, development and design of products for manufacture and use.

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letters to the editor

Vanishing Engineers

Congratulations on printing the excellent article on "Nationalization of Research and Development in the United States" by J. C. DeHaven (*CEP*, October 1957, page 19). It brings into focus a problem which we who are in the field of engineering and science have realized [only] vaguely.

You probably have heard President Eisenhower's recent televised addresses to the people of the United States in which he exhorts them to improve their school system, and in which he also suggests that free scholarships and other inducements be offered to encourage promising students to enter into scientific studies. However, not one word was mentioned about increasing the compensation of those who have been graduated and are already employed in the pursuit of scientific knowledge and engineering skill.

It should be apparent from the high percentage* of scientifically trained people, or those trained in engineering, who leave their technical careers to become salesmen, managers, executives, etc., that the lack of financial reward in their chosen field of study has forced them into such other occupations. The Russian science graduate, on the other hand, obviously very rarely leaves the field in which he specializes. Thus, if the Russians graduate twice as many science students as we do, their overall gain in personnel remaining in the field is probably greater than ours by a factor of 4 or more. This is a *most serious problem.*

The President's solution, as thus far stated, presents an even more dismal picture. True, we can temporarily increase the rate of education of our scientists—but what then? Unfortunately, the law of supply and demand still applies to industry. With the increased supply of technically trained people, salary levels will undoubtedly be reduced. The lack of financial reward after graduation will far overshadow the educational inducements offered by the government, and leave science and engineering in a sorry plight.

It is conceivable that such a "recession" might once again divert students from being attracted to science and engineering careers, and might also force the practicing engineer into unionization rather than maintaining his traditional professionalism.

Quentin R. Jeffries
Terre Haute, Indiana

* There are various evidences of this mass migration—a quantitative example appeared recently in Dael Wolfle's *America's Resources of Specialized Talent* (Harpers, New York, 1954). This reports a study of occupational distribution of Ohio State and Michigan U. living male graduates in the U.S. from the classes of '51, '41, and '31. In 1953, when the study was made, it was found that only 64 per cent of these men who had graduated as engineers were still working as engineers.

What Does "Shortage" Mean?

The same "facts" that leave Mr. De Haven (Nationalization of Research & Development in the United States, *CEP*, 53, No. 10, p. 19) with little doubt (tongue in cheek?) of the "critical nature of the engineering shortage," leave me with a great deal of doubt.

I was chairman of a session on Education at the American Nuclear Society's recent New York meeting. In preparation for this job I took a careful look at the manpower statistics for the nuclear industry. This is our fastest growing industry, and shortages of scientists and engineers, if they exist, should be felt here. My interpretation of the Atomic Industrial Forum's Manpower and Industry surveys are as follows:

- **There is absolutely no shortage at all. As a matter of fact, personnel affected by recent AEC and industry cutbacks are being assimilated very slowly indeed.**
- **Even if the optimistic growth projection curves for the industry are realized, according to my calculations only 2,500 new jobs will be created by 1960. We are training approximately 25,000 engineers and scientists a year.**

Mr. De Haven also seems to be reaching for a method of defining the word "shortage." He overlooks one simple definition. A shortage exists if companies are forced to stop scheduled work because of lack of manpower. Again, on the basis of the AIF surveys, no shortage exists. Lack of manpower was listed as a fourth-order deterrent to industrial expansion.

I applaud Mr. De Haven's article in so far as it points up the salary anomalies, and one of the reasons for them. On the other hand, this is a second-order effect. The real answer to this problem lies in uniformly stiffer entrance requirements and levels of training in our engineering schools. If we are to retain the liberal arts credits in our courses and still train applied scientists rather than technicians, a basic five- or six-year program is clearly called for.

This would result in eliminating all but the interested and capable from the profession. The gradual elimination of the trial-and-error and by-guess and by-god engineers would lead to a solution of both the manpower and salary shortages. A dab of good perfume goes much further than a bottle of cheap cologne.

Ernest J. Henley
New York, New York

Engineer-Politician

In Noted and Quoted, *CEP*, October, 1957, Governor McKelden of Maryland discusses political activity in the broad sense (see: "The Chemical Engineer and Politics"). We certainly agree with his suggestion of finding out more about problems by taking a hand in the effort to solve them and in the broad responsibility we all should recognize and assume in our public affairs. May we call to your attention another more conventional political activity in which a chemical engineer has demonstrated his ability and interest—Toledo, Ohio, has just elected a chemical engineer to city council.

With no political experience, Joseph R. Scalzo, assistant chief chemical engineer for Sun Oil, Toledo refinery, and one of the founders and past chairman of A.I.Ch.E. Toledo Section) ran third in a field of eighteen candidates to fill a council of nine. For a newcomer this is a real accomplishment. While Mr. Scalzo has no previous political experience, we hasten to point out that he has more than served his community in Gov. McKelden's broad sense. His many civic activities range from coaching the United States Olympic Wrestling Team to serving as chairman of the city of Toledo Water Softening Study Committee.

It is refreshing to find a technical man with qualifications of leadership and vision who will take a place beside our politicians. Certainly, I do not expect that all chemical engineers or technically trained men should seek public office, or that all offices should be filled by men with this kind of a background. I feel strongly however, that many situations confronted by our elected officials require the analytical ability which we demonstrate so admirably in the routine execution of our technical work. One might ask that since society cannot escape our technical influence, cannot we also be an active political influence in our society?

Clyde W. Balch
Toledo, Ohio

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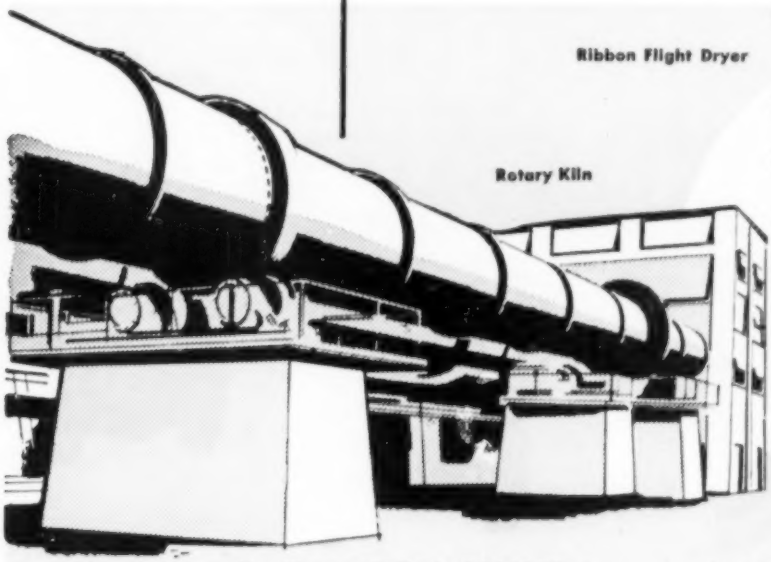
- Petroleum Coke
- Fuller's Earth
- Nickel Ores
- Copper



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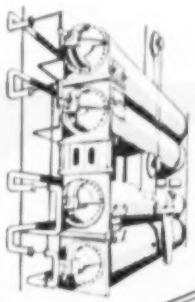

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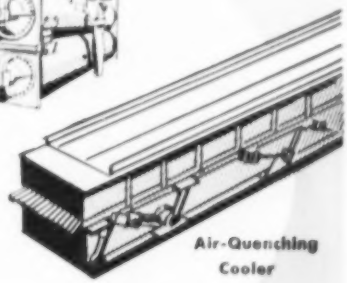

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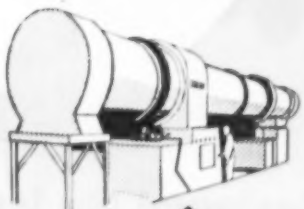

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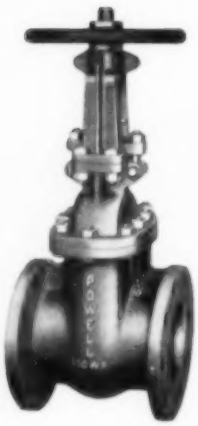

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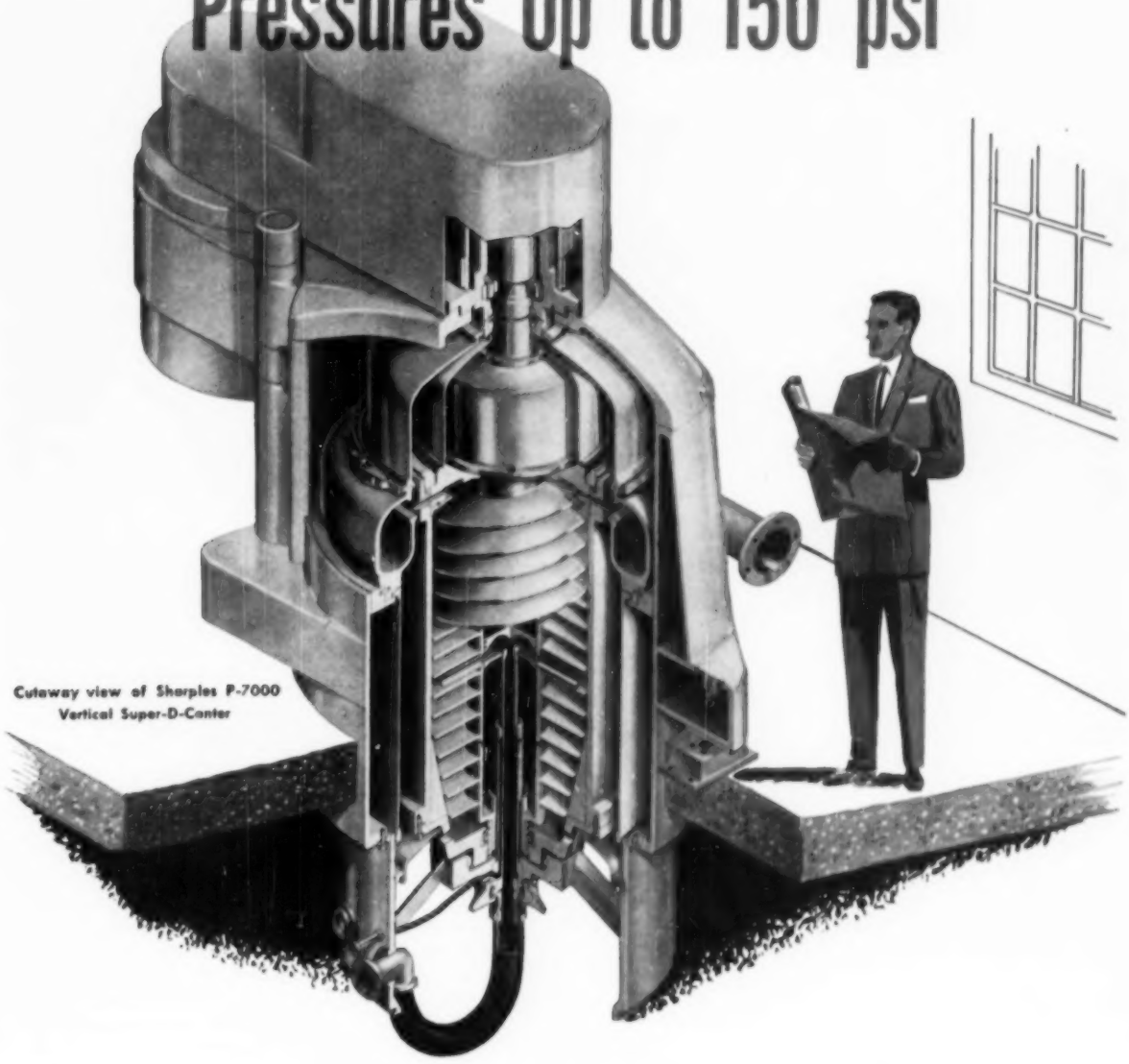

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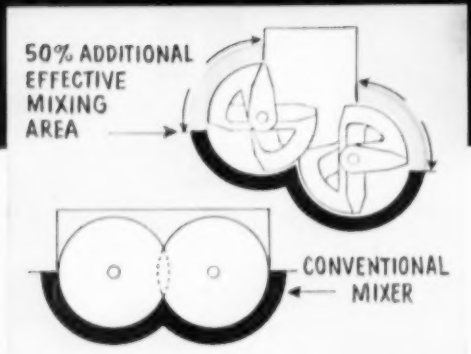

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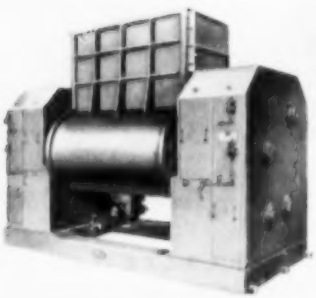

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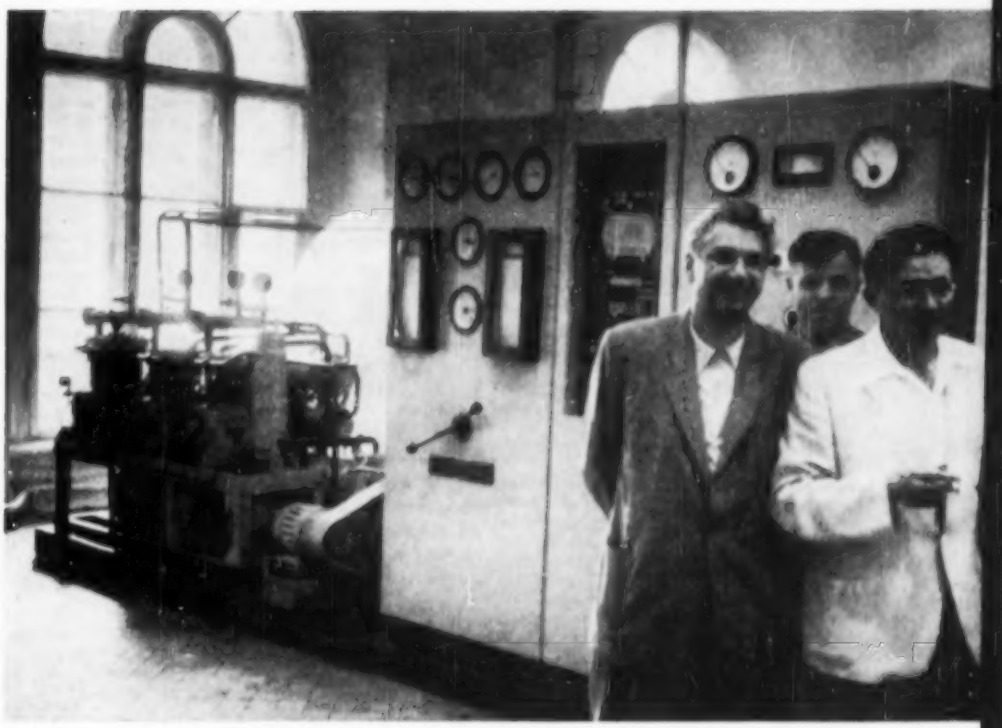


Soviet chemical engineers and a modern control panel. (To be described in a subsequent article by Piret.)

a chemical engineer visits the USSR

The author standing before the entrance to the Presidium of the USSR in the Kremlin.

Edgar L. Piret

Department of Chemical Engineering
University of Minnesota
Minneapolis, Minnesota

Recently, as a member of a five-man technical mission* arranged by the U. S. State Department, I had an opportunity to visit and study for a three-week period the large peat industry of the USSR. It was also possible to visit Soviet institutions of education and research, including several devoted specifically to chemical engineering. This paper will serve as background for a later report on chemical engineering in the USSR.

Soviet engineers and professors were always cordial, open, and informative in their discussions. The officials place no restrictions on the taking of pictures and several requests to see laboratories and special items of interest were granted. As a consequence, the trip proved most interesting and informative. The fact that we were official guests of the Ministry of Fuel and Power undoubtedly eased these visits greatly.

A visitor to Russia will frequently and most forcefully be struck by the seemingly sudden Soviet scientific development, and by the sharp contrasts in advancement which he sees. He will find it difficult to draw conclusions, because at one moment he may see a modern laboratory or apparatus of advanced design, yet in the next moment he will see equipment, a design, or working methods of several decades ago.

Perhaps a more startling experience is to discuss a right up-to-the-minute engineering subject with a Soviet engineer thoroughly familiar and up-to-date in his field, and then a few minutes later suddenly discover that despite his obvious goodwill, intelligence, and high education, this same engineer's knowledge of the true economic, social, and political conditions in the United States is highly inaccurate and out of date by 25 or more years.

In several laboratories, I noticed very recent issues of American chemical engineering and chemical journals and it was easy to talk with Soviet chemical engineers and other technical men about modern engineering problems—for example, a theoretical or experimental aspect of the unit operations. They were well informed, talkative, and described their interests and problems in education and research in an open, stimulating manner.

In almost terrifying contrast because of its significance, I saw not a single American or,

* Sponsored by the Iron Range Resources and Rehabilitation Commission, State of Minnesota.

for that matter, English or other West European newspaper or popular magazine on sale in any hotel lobby, railroad station, department store, bookstore, or bookstand.

One sees many such American items even in the lesser cities of France, Finland, Germany, Italy, Sweden, etc. Lack of interest in the U.S. or inability to read English* most certainly is not the cause of this conspicuous absence of information. Time and again in the U.S.S.R., I (and others of our group) was asked by people in the streets, by students and others, for any American book, magazine, or even scrap of newspaper that might have wrapped a package in our luggage.

When I speak of English language and Western European publications, I am of course excluding such newspapers as the French communist Humanité, Moscow News (published in Moscow), copies in libraries, books by James Fenimore Cooper and other classics of years ago, and especially what to me were obviously carefully-selected volumes of highly unrepresentative western writers. These publications unfortunately leave the Soviet man with the erroneous impression that he is well informed about the outside world. He does not even know that he doesn't know.

Thus, on one hand we see that the Soviet engineer has ready access to, and uses, the latest technical literature of the West. On the other hand, the same man has no effective access to our newspapers, or even to our most popular magazines or representative contemporary literature. Most tragically, what I did hear on every hand about our country and its people was highly inaccurate and warped. It recalled to me the parallel situation I met in Germany in 1936.

The need for a broad and early flow of information and understanding is all too clear.

* 65 per cent of the students in the Soviet institutions of higher learning study English, according to the recently released report on Soviet Education by the U. S. Office of Education.

Certainly, the people I came in contact with professionally in the Soviet Union are intellectually capable of better understanding us and our way of life, given more information. So there is a chance that efforts in that direction would result in substantial gains.

It is generally known that the U.S.S.R. is now, in a highly planned and vigorous manner, concentrating much effort on the technology and mechanization of its basic industries. Also, it appeared to me that Soviet government policy is to give the highest priorities—and to support on a scale unprecedented in world history—to its scientific, engineering, and industrial research and development personnel and laboratories. Still more significant, because of the certainty of the effects within 10 to 15 years, is that this expansion of industry and of basic and of applied research is now being supported with a vigorous modernization and expansion of the educational centers for the training of engineers and scientists. Automatic control and the use of recording instruments seems to be particularly emphasized in the chemical engineering educational program.

The present status of Soviet science and engineering, as related to that of the Western World, is of course difficult to assess accurately in a short visit to the country. But it was evident to me after having seen several laboratories—and particularly after observing in detail the methods and the scale with which they are carrying on the peat industrial research program—that the Soviets have, in that field at least, advanced to where they are using modern engineering techniques, modern methods of industrial product and process development, and modern managerial techniques.

For example, we were shown an extensive laboratory program in which comprehensive and accurately-taken data were being used to calculate economic optimum for projected processes. For other similar projects several pilot units were testing the laboratory results. Surprisingly, several large scale semi-works operations were also being run in parallel to decide, under essentially full-scale conditions, the costs of competing processes. Within a single ministry and program the Soviet system allows for the evolution of more than one process all the way up to and including full-scale production. Each stage is evaluated in terms of rubles/ton, including such items as raw materials, labor, transportation, amortization of plant, amortization of equipment, safety clothing, etc. The only items I have found missing were interest on capital and social security.

The concentration of effort and of funds on technical education, research, and development for heavy industry and for the military is inevitably taking place at the expense of the living standards of the people.

Certainly the people of Moscow, Leningrad, and of the smaller towns and villages I saw have a Spartan or less existence. They see few, if any luxuries. The living standards of the Russians are far below our own, but as far as I could tell, these standards were not so low as to provoke violent discontent. Most Russian people simply have no knowledge of the

Top, students, and below, marble halls at the University of Moscow on Lenin Hills.

In the street scene below the people are adequately, if not well dressed.

conditions in the outside world. Their basis of comparison is their past. After all, the history of Russia has always been an unhappy one, with oppression and grinding poverty the lot for nearly everyone.

The Russian people I saw in the cities were adequately, if only roughly clothed and seemed adequately nourished. It was stated that a great improvement in clothing had occurred in the past three years.

The accompanying table shows that the lot of the young Russian engineer is today poor when compared with his American counterpart. For example, about 10 per cent of a young Soviet engineer's monthly salary is gone when he buys a single pair of very ordinary quality shoes. A similar pair of shoes would cost a young American less than 2 per cent of his monthly salary of $475. A good pair of shoes is practically unobtainable for the young Russian since he would have to pay nearly two weeks salary for them. A small Volga car, whose equivalent here would cost the young American about four months salary, represents so many months of work (15) for the Russian that it is clearly out of reach.

The table appears to show that as far as his monthly earnings are concerned, the starting salary of the young Russian engineer is only a little above that of other workers in the country. However, special privileges of many kinds typically reserved for select groups in the Soviet system, status, and earnings potential as indicated in the table make the young engineer's situation an enviable one when compared to others in Russia.

Above: two engineers and a student. Are these Washingtonians or Muscovites? Below, left: the women lay bricks, build roads . . . and many study chemical engineering. Below, right: Moscow University "skyscrapers."

SALARIES IN THE USSR

(As told by several different persons to E. L. Piret in Russia in July, 1957)

Non-qualified labor—500 rubles per month.
Women sod pickers—700 to 800 rubles per month.
Taxi drivers—800 to 900 rubles per month.
Women on construction jobs—600 to 1,000 rubles per month.
Women guides, university graduates—800 rubles per month.
Tractor drivers in peat fields—900 rubles per month.
Peat field supervisors—2,700 rubles per month.
Engineers just out of school—1,000 rubles per month.
Engineers with 15 years experience—3,000 to 4,000 rubles per month.
Coal miners—3,000 to 4,000 rubles per month. (Recognizing essential and dangerous work.)
Machinists (48 hours per week)—1,000 to 2,000 rubles per month.
High School teachers—1,200 to 1,500 rubles per month.
Medical Doctor or Lawyer—1,500 to 1,800 rubles per month.
Chemists (with four years training)—
After 10 to 15 years' experience—1,500 rubles per month.
With a Kandidat—2,800 rubles per month.
With a Doktor—4,500 rubles per month.
Engineering assistant to a deputy minister of the government—2,500 rubles per month.
Manager of a 500-man plant—3,500 rubles per month plus additional facilities (car, apartment, etc.).
Professors at a university—6,000 to 11,000 rubles per month plus additional facilities (car, etc).
President of the Academy of Science is the highest salaried individual in the USSR.
Artists' salaries are very, very high; e.g., a top dramatist—20,000 rubles per month.
A party member receives no pay for his political work (I was told).

Prices

Moscovite sedan—15,000 rubles.
Volga sedan (comparable to a very small European Ford)—30,000 rubles.
Ordinary quality dress shoes—100 rubles.
Good quality shoes—300 to 400 rubles.
1 Kg. butter—28 rubles.
1 Kg. white bread—1 ruble.
1 Kg. good meat—10 rubles.

Exchange Rates

Commercial: 1 ruble = 25 cents U. S.
Tourist: 1 ruble = 10 cents U. S.

He is also at a decided advantage relative to highly trained professionals in non-technical fields.

Then, too, if he, for example, manages to become a staff member and ultimately a Professor at an institute of engineering education, he achieves not only one of the most remunerative positions, but one held in highest honor in the community.

The Russian of the cities must be particularly conscious of the educational and technical advancements of his country which are displayed before him in the form of elaborate, permanent educational exhibitions intended to excite him with their implied promises for the future. High buildings, ornate subways, and immense stadia also feed emotional hungers. Amusement parks are lined with posters showing industrial production curves, with increasing slopes for the future, and slogans inciting the Russian to greater efforts (much like our own war-time posters). There are no advertisements increasing his appetites and urging him to buy. Nor is knowledge of the outside world, or of what he does not have, available to disturb him from his tasks. The Russian citizen is apparently expected to feel that he has considerable economic freedom since he can within his organ-

ization criticize work methods, foremen, etc. Political freedom he has never had and probably does not miss. Morality is identified with the good of the Party and religion is mere superstition.

The decision to concentrate much effort on education for science and engineering, on research and development, etc., at the expense of other facets of national life, is of course a result of policy decisions which can most easily be imposed on a nation by decisive authority from above.

The new buildings of the University of Moscow represent one recent, peak result of such a policy. This large group of structures located on the Lenin Hills overlooking Moscow cost $300 million to build. This is a recent project, built in 1949-1953, and consists of a main 32-story building and 36 other buildings situated in a park-like area of some 800 acres. With its 43 elevators, marble halls and corridors, it is impressive. Its design, however, leaves much to be desired from the viewpoint of efficiency. The main point to be noted is that this new University of Moscow, with its 23,000 students, trains scientists exclusively—chemists, physicists, mathematicians, geographers, geologists, etc. The literary and other less favored faculties are still located in the antiquated, crowded buildings of the old University in downtown Moscow. This new palace of education-for-science on Lenin Hills, the many well-supported institutes for enginee ing, education, and research, and the incentive of high rewards are clear indices of the great value which the Soviet government attaches to the advancement of science and engineering and to education for these fields.

All this concentration on technology of course fits in with the materialistic philosophy of the Communists. However, it should not be inferred that there is no cultural activity. A visit to the ballet at the Bolshoi Theater or to an outdoor performance at the Kyrov Stadium, or a recalling of modern Soviet composers will quickly show that this is not so. I was told that there has been a most extensive development over the whole country of many schools of music and that there is a strong interest in poetry. The paintings that I did see, however, appeared completely unimaginative and stagnant. The multitude of crowded bookstores and bookstalls lining the main streets of Moscow, of Leningrad, and other towns we saw is indicative of a wide interest in reading.

One sees in city parks, along highways, in the subway stations, and also in small towns, statues and posters showing a young man or girl studying a book. These apparently are ideals to which the Soviet youth is exposed. The presence and significance of such statues is less surprising when one is informed that in the last forty years the Soviets have raised themselves by their own bootstraps to increase the number of students in their schools from less than 10 million to more than 34 million today and that universal secondary education is planned by 1960. Illiteracy has been essentially eradicated. A new nation has taught itself within two generations—young and old alike—to read and to write and has produced in 1955 young scientists and engineers at double the rate of our U.S.A.—the most advanced and powerful industrial nation of the world. Today Russia is reported to have 70,000 or so Ph.D's in science and engineering.

There are now 33 Soviet universities and a multiplicity of technical institutes and research organizations which inevitably have affected and will continue to raise the scientific and technical skills of the Russian.

A visitor naturally searches to find the incentives used to promote so much advanced study and research in the U.S.S.R. The answer came quickly. Money and prestige, as might be expected, are the incentives used even in Russia today. They are a measure of the value of the individual's contribution to the State.

A Soviet student enters a higher technical school through severe competitive examinations and is considered to be working for the State as he would in an industrial plant. There are no tuition fees since last year, and all successful students have substantial scholarships. Retention of these scholarships (as well as their amounts and privileges) is related to scholastic performance, as is the job to which the graduating student has access. As has been pointed out, the rewards available to the engineering graduate —and particularly to the engineering educator—are considerable.

The directions in which the best talent tends to flow under such circumstances are obvious, and the effect upon the quality and number of high grade engineers and scientists available to the nation follows.

Our own industrial experience has demonstrated, in no uncertain terms, that it is essential for a corporation to have a strong research and development program if it is to maintain its position relative to competition. Our earnest competition for the future is no longer largely between corporations: it is between our nation and the U.S.S.R. It is a challenge to each one of us.

The effects of the Russian policy for education and research on the development of the Soviet State are already clear. If the United States invests heavily in better education and basic research it can be certain of a high return in a few years in the welfare and material wealth of the American people. It is a good investment even without considerations of national security. Its achievement, however, will take more than investment.

IMPRESSIONS THAT REMAIN

- **The high personal qualities and drive of the men who received us in their laboratories and plants.**
- **The burdens evident in the faces of the people we saw in the villages—a reminder of our common humanity, problems, and hopes, and the need for justice and for peace in the world.**

Street scene in downtown Moscow.

ADVERTISEMENT—*This entire page is a paid advertisement* *Prepared by U. S. Industrial Chemicals Co.*

U.S.I. CHEMICAL NEWS

December ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1957

U.S.I. Among Winners of Chemical Engineering Achievement Award

The 1957 Award for Chemical Engineering Achievement, presented at *Chemical Engineering's* Annual Award Dinner at the Waldorf-Astoria in New York on Tuesday, December 3, is a group award recognizing the pioneering application of chemical engineering principles and processes in extractive metallurgy.

U.S.I. is one of 75 organizations in industry and government to share this honor, and is cited for its contribution to zirconium and titanium process technology. The U.S.I. processes for these metals are based on sodium reduction of the metallic tetrachlorides and are believed to be the most economical processes developed to date for the production of metal sponges.

The citations of the Committee of 90 senior educators, under the chairmanship of Dr. Walter Whitman of M.I.T., are limited to the newer metals: uranium, plutonium, zirconium and hafnium, tantalum and niobium, lithium, boron, beryllium, thorium and the rare earth metals. Also included as important to the nuclear industry are aluminum, nickel and titanium.

New Process to Synthesize DL-Piperitone Depends On Sodium Dispersions

DL-Piperitone can now be synthesized from ethyl acetoacetate, a by-product of neoprene manufacture. As against natural piperitone, a synthetic material has the advantage of dependable supply. Consequently an efficient and inexpensive method of commercial production has been sought for some time.

The technique of dispersing metallic sodium in inert hydrocarbon media, developed and perfected over the past several years by U.S.I., is at last providing a practical solution to the problem. A proposed commercial process based on this techni e follows:

(1) Sodium and isooctane are agitated together to form a dispersion which is added to ethyl acetate in the mole ratio of 7.3 to 1. The resulting solution is heated.

MORE

Vinyl Heat Stability Improved When ISOSEBACIC® Acid Is Used As Plasticizer Intermediate

New Plant Starting Up To Produce ISOSEBACIC Acid

A newcomer among plasticizer intermediates, ISOSEBACIC acid, is improving the heat stability of polyvinyl chloride films. The table below is based on tests conducted by a formulator of top-grade films for seat-cover use. It gives the comparison between diisooctyl Isosebacate, an ester of ISOSEBACIC acid, and a commonly used plasticizer, diisodecyl adipate.

Comparing columns (1) and (2), it can be seen that heat stability improves 50%, from 30 to 45 minutes, when 15 parts of the Isosebacate replace an equal quantity of adipate. A comparison of columns (3) and (4) reveals that heat stability is improved 100%, from 30 to 60 minutes, when both ester concentrations are raised to 22 parts.

Tests also indicate that ester plasticizers formulated with ISOSEBACIC acid have improved color, odor, and oil and soapy water extraction properties. These properties are important for applications such as auto seat covers, furniture upholstery covers, shower curtains, luggage and handbags.

ISOSEBACIC acid is a mixture of isomers of sebacic acid in about these proportions:

2-ethyl suberic acid	72-80%
2,5-diethyl adipic acid	12-18%
sebacic acid	6-10%

In addition to the vinyl plasticizer application, the material is being evaluated in polyurethane foams, polyamides, polyesters, alkyd resins and jet lubricants.

ISOSEBACIC acid is a product of U.S.I. research. It is derived from butadiene and sodium, both available in unlimited supply. U.S.I. is now in the process of starting up its new ISOSEBACIC plant at Tuscola, Ill.

Diborane Now Produced Commercially; 3 Amine Boranes Being Researched

Diborane, precursor of pentaborane rocket fuel and promising as an intermediate, reducing agent, catalyst and flame speed accelerator, is being marketed in commercial quantities.

According to the manufacturer, physical and chemical properties are now completely determined. Chemical reactions which have been thoroughly investigated include those with ammonia, amines, phosphines, ethers, carbonyl compounds, hydrocarbons, metal alkyds and hydrides, and sodium.

Amine Boranes in Research Quantity

Also available, although in research quantities only, are dimethylamine-borane, trimethylamine-borane and pyridine-borane. Their utilization as selective reducing agents in non-aqueous solvents has been of most interest. They are polymerization catalysts and inhibitors for acrylates and vinyl compounds. In addition, applications as antioxidants and stabilizing agents have been suggested as promising possibilities.

Table of Field Test Data Comparing Diisooctyl Isosebacate Against DIDA as a Vinyl Plasticizer Intermediate

FORMULATION	Parts Per Hundred of Resin			
	1	2	3	4
PVC	100	100	100	100
DIOP (diisooctyl phthalate)	18	18	22	22
DIDA (diisodecyl adipate)	15	—	22	—
Diisooctyl isosebacate	—	15	—	22
Phosphate plasticizer	11	11	—	—
Stabilizer A	2	2	2	2
Stabilizer B	1	1	1	1
Stabilizer C	1	1	1	1
1. Volatility (active carbon method) 24 hrs. at 158°F, % loss	1.38	1.21	0.92	1.07
2. Clash-Berg, Tf, °C	−24.4	−20.0	−23.9	−23.4
3. Heat Stability, minutes stable at 350°F	30	45	30	60
4. S.P.I. Impact Test (Masland) Pass/Fail °F	−20/−25	−20/−25	−20/−30	−25/−30
Gauge	0.019"	0.020"	0.019"	0.021"
5. Germicidal Lamp Test, 16 hrs, tack	slight	slight	slight	slight
6. Blooming, Room Temperature, press polished	O.K.	O.K.	O.K.	O.K.

CONTINUED

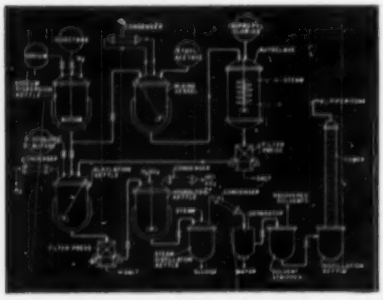
DL-Piperitone

(2) When reaction is complete, isopropyl chloride is added and the mixture is heated.

(3) The resultant slurry is filtered and the filtrate is alkylated with dispersed sodium to form the sodium enolate of ethyl oxisopropyl acetoacetate.

(4) 1,3-dichloro-2-butene in anhydrous benzene is added, and the mixture is refluxed until neutral.

(5) After filtration, the mixture is hydrolyzed with sulfuric acid, distilled and stripped of solvents. A crude, high-boiling dl-piperitone results. Further distillation yields pure dl-piperitone.



With this process, synthesis of DL-piperitone is reported to be commercially feasible.

New Standard Issued on Polyethylene Plastic Pipe

A new Commercial standard for black flexible polyethylene plastic pipe has been established by the Dep't. of Commerce, in cooperation with the Society of the Plastics Industry and the Nat'l. Sanitation Foundation.

The new standard, CS 197-57, specifies that "... the pipe shall be manufactured of virgin polyethylene, that no scrap material has been used, and that it is satisfactory for potable water." It also lists new dimensional tolerances and testing procedures.

Copies are available from Superintendent of Documents, U. S. Government Printing Office, Washington 5, D. C. for 10¢ a copy.

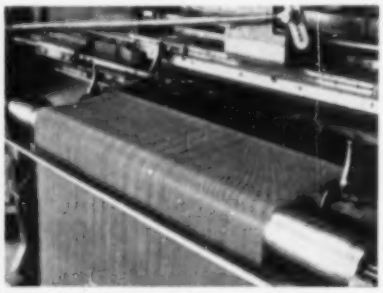
Corrosion-Resistant Mesh Is Now Produced with Improved Titanium Wire

The fabrication of titanium wire cloth now has reached a production basis. This is due primarily to improvements in quality of wire, which until recently lacked the needed uniformity and elongation, and had a tendency to work-harden rapidly and gall on metal-to-metal contact.

With wire-forming problems licked, and cloth being fabricated efficiently with high-purity and ductile grades of mill product, new applications are developing rapidly. Although noted for its high strength-to-weight ratio the biggest advantage of titanium in wire cloth form is its unique corrosion resistance. The metal has a corrosion rate of only .00000! inches per year in sea water, and is not subject to stress corrosion cracking in sea water or sea air.

Titanium wire cloth is being fabricated more and more into filter screens, catalyst screens or similar assemblies, where it handles mineral acid solutions, sodium hypochlorite, chlorides of all kinds, organic acids, alkalies and other reagents, with superior resistance to corrosion.

Several companies also report ability to make woven screen from zirconium wire, for those applications where zirconium corrosion resistance is superior to titanium.



Titanium wire cloth being woven (photo courtesy Cambridge Wire Cloth Company).

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U. S. I.

A silicone rubber which vulcanizes at room temperature has just been introduced for encapsulating, potting, sealing and caulking. Retention of rubber-like properties from —70 to 500°F is claimed. **No. 1301**

"The Rudiments of Feed Formulation", a 6 page reprint reviewing the industrial sources of animal feed constituents, the formulation of mixed feeds and the energy and nutrient values found therein, is now obtainable on request. **No. 1302**

A new monomeric ester-type plasticiser for vinyls and cellulosics is described in a 4-page data sheet now available. Chemically it is di-2-ethylhexyl isosebacate, reported about ½ lower in cost than the corresponding sebacate. **No. 1303**

Entirely new series of high molecular weight diazo red pigments for PVC and latex paints is said to combine the strength and brightness of organic pigments with the stability normally associated with inorganic pigments. **No. 1304**

Thioglycolic acid — its properties, reactions and uses — is described in a new 20-page catalog now available free of charge. An extensive bibliography of relevant patents and trade paper articles is included. **No. 1305**

Ethyleneurea (2-imidazolidinone), a new chemical, is now on the market. Used to make lacquers, varnishes, finishing agents, adhesives, plasticizers. Forms highly polymerizable vinyl and other derivatives. **No. 1306**

New series of zinc rich coatings to protect steel from the atmosphere and in marine and chemical use has been developed. Applied by brush or spray. Are said to be tougher, tighter, better bonded than old-type zinc coats. **No. 1307**

New adhesive for polyurethane foams is made with new, extremely fast-drying polymer, is said to lose its depression tack faster than any other material on market. Permits bonding with an adhesive as soft as the foam itself. **No. 1308**

A gas analyzer for measuring trace hydrogen, oxygen and nitrogen in metals has just been introduced for use right in the mill. Claimed to be only apparatus on market for both vacuum fusion and extraction. **No. 1309**

Pyridine N-oxide can now be obtained in commercial quantities. This exceptionally reactive derivative can be used to prepare many other pyridine chemicals valuable to the drug, dyestuff and allied industries. **No. 1310**

PRODUCTS OF U.S.I.

CHEMICALS FOR PLASTICS

ISOSEBACIC® Acid: mixture of isomers of C_{10} aliphatic dibasic acids.
PETROTHENE® Polyethylene Resins.
Butanol (Normal Butyl Alcohol): solvent for resins.
ANSOL® M: anhydrous denatured alcohol, special blend for resins.
ANSOL® PR: anhydrous denatured alcohol, special blend with higher ester content.
Normal Butyl Acetate: medium boiling solvent for nitrocellulose.
Ethyl Acetate, 95-98%: solvent for cellulose derivatives.
Ethyl Ether, Technical: solvent for resins.
Acetone (Dimethyl Ketone): solvent for vinyl resins, cellulose acetate.

OTHER PRODUCTS:

Alcohols: Ethyl (pure and all denatured formulas), Normal Butyl, Amyl, Fusel Oil, Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL® M, ANSOL® PR.

Esters, Ethers and Ketones: Normal Butyl Acetate, Dibutyl Phthalate, Diethyl Carbonate, Diethyl Oxalate, Ethyl Acetate, Ethyl Ether, Acetone, Diatol®.

Intermediates and Fine Chemicals: Acetoacetarylides, Dimethyl Hydrazine, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Chloride, Ethyl Sodium Oxalacetate, U.S.I. ISOSEBACIC® Acid, Methyl Hydrazine, Sodium Ethylate Solution, Triethyl Aluminum, Trimethyl Aluminum, Urethan USP (Ethyl Carbamate).

Animal Feed Products: Calcium Pantothenate, Choline Chloride Products, MOREA® Premix, Special Liquid Curbay®, DL-Methionine, Niacin USP, Riboflavin Concentrates, Vitamin B_{12} and Antibiotic Feed Supplements, Vacatone® 40, Vitamin D_3 and K_3 Products, Antioxidant (BHT) Products, Special Mixes, U.S.I. Permadry Products (Sealed-In Vitamin A).

Inorganic Chemicals: Ammonia, Caustic Soda, Chlorine, Metallic Sodium, Sodium Peroxide, Sulfuric Acid.

Metals: Titanium Sponge, Zirconium Sponge, Zirconium Platelets, Hafnium Oxide, Hafnium Sponge.

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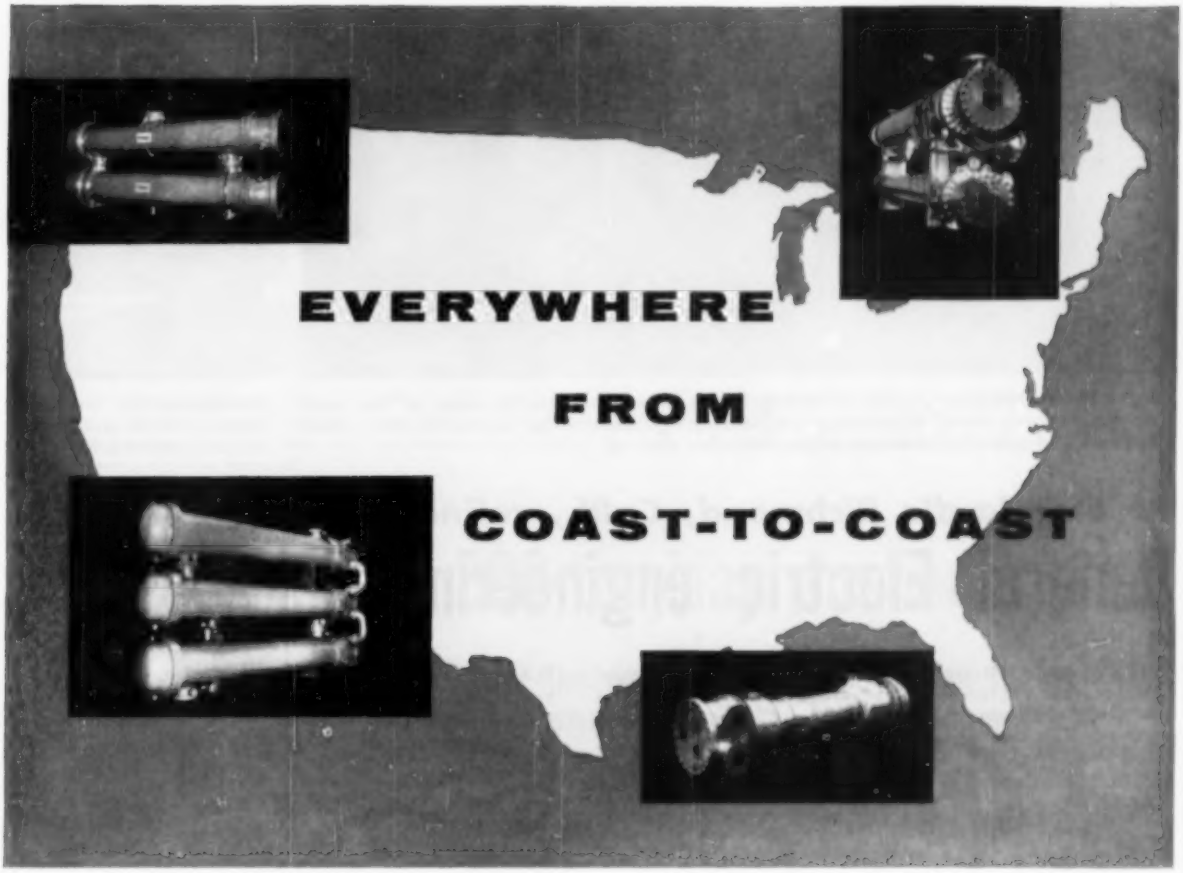

YUBA ENGINEERED HEAT EXCHANGERS

Complete facilities for the production of the finest heat exchangers are at your service at Yuba. With branch offices and representatives at every principal point throughout the country, Yuba is able to have a sales-engineer at your desk in a matter of hours to help you start your heat exchanger project.

At three of Yuba's plants at Honesdale, Pa., Buffalo, N. Y., and Richmond, Calif., are top heat exchanger engineers with national reputations for their progressive designs. Daily they design all types of heat exchangers, large or small, simple or complex... heat exchangers which operate at vacuum or to pressures of 5000 psi, at temperatures below zero or to 1000 F and higher . . . heat exchangers made of all kinds of metals: carbon steel, alloy steel, aluminum, nickel, and non-ferrous alloys such as the new silicon bronzes... heat exchangers with bundles having a few tubes or as many as 7500, with heat transfer surfaces up to 15,000 and 20,000 sq. ft.

Yuba is experienced... some of its divisions having made heat exchangers for as long as 50 years. Yuba has outstanding techniques... many of its heat exchangers having been "firsts" in their fields. Yuba is nationally recognized... in the chemical, oil, gas, power, mechanical and heating industries.

Buy Yuba. Its plants in both the East and the West mean convenience for you, speedy delivery, service . . . but, above all, well-engineered heat exchangers tailor-made for your own process.

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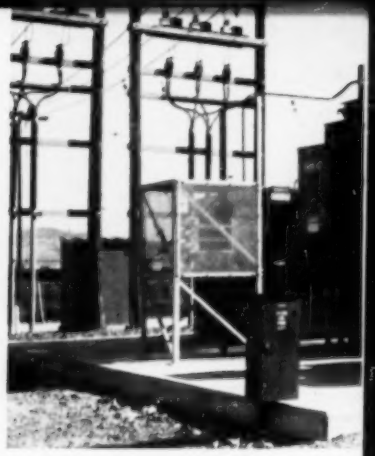
BUILT IN 14 MONTHS by The M. W. Kellogg Co., new ammonia plant is a unit of Standard's Richmond refinery, one of West's largest. All electric equipment is by General Electric, which also provided engineering service to help achieve fast start-up.



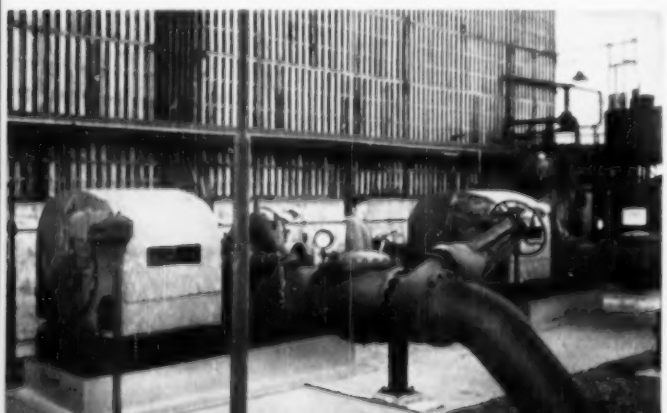
CO-ORDINATED for top reliability, G-E equipment in master substation for ammonia

At Standard's Richmond, Calif., refinery . . .

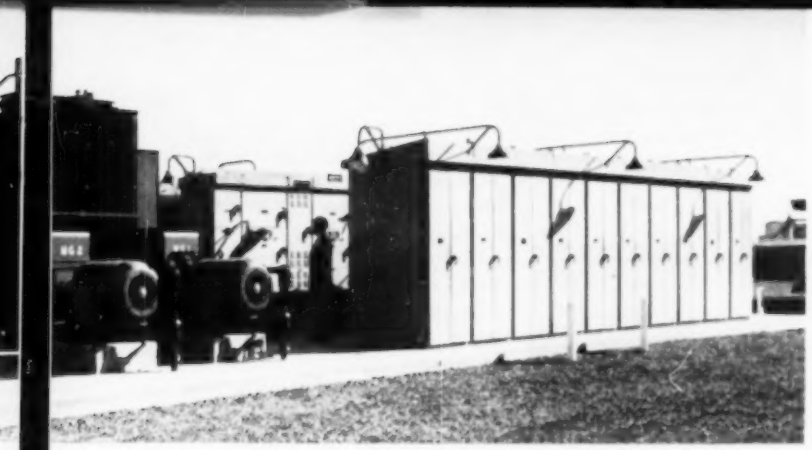
General Electric engineering services help

OUTDOOR-LOCATED on platform to drive compressors are 8 high-efficiency, enclosed, force-ventilated G-E synchronous motors (3 shown) with excitation obtained from substation's d-c m-g sets.

WEATHER-PROTECTED, 2 rugged 350-hp G-E induction motors drive cooling-water pumps. Other plant induction motors are either enclosed force-ventilated or explosion-proof, fan-cooled.



PLANT'S BIGGEST, a 4000-hp 12,000-v totally enclosed force-ventilated G-E induction motor drives synthesis gas compressor. Explosion-proof 60-hp G-E motor (r.) drives blower



plant includes 5000-kva transformer, 17 units of 12-kv metal-clad switchgear, 2300-v Limitamp* motor starters, 480-v outdoor motor control centers, 2 outdoor motor-generator sets, and two 480-v transformers.

*Registered trade-mark of General Electric Co.

EASY MAINTENANCE of plant's G-E metal-clad switchgear is shown by workman removing vertical-lift, magne-blast circuit breaker for inspection.

speed opening of 300-ton/day ammonia plant

drawing clean air—via black ductwork and mushroom tower—from upper level of uncontaminated atmosphere.

General Electric power system, installed to meet rigid construction schedule, helps plant get fast start on profitable production

Standard Oil Company of California, Western Operations, Inc., recently added to its Richmond, California refinery—the largest west of the Rockies—a new $11 million ammonia plant designed, engineered and built by The M. W. Kellogg Co. The plant's capacity of approximately 300 tons per day of anhydrous and aqueous ammonia is shipped to nearby California Spray Chemical Corp., a subsidiary, for conversion into fertilizer.

GENERAL ELECTRIC supplied the new plant's electric equipment—compressor drives, auxiliary motors, and complete outdoor substation with co-ordinated components. In addition, General Electric engineering services helped both customer and designer get the new plant from the discussion stage to on-stream in only 14 months.

An example was the contribution of General Electric installation and field service engineers. By supervising the installation of the electric equipment as scheduled deliveries arrived, they helped reduce field installation costs, speed completion of construction schedules, and hasten start-up time. To Standard, this meant getting into production faster, and thereby, showing a return sooner on the large capital investment tied up in the plant.

IN ADDITION, the 17,000-kva block of power will be integrated into the existing plant system. General Electric application engineering services, working closely with Standard and Kellogg representatives, helped provide the electrical equipment co-ordination and integration necessary to meet the plant's process power requirements.

For *your* new chemical plant, too, General Electric offers a one-manufacturer source of quality electric equipment and valuable engineering services to help provide you and your process contractor with an efficient, co-ordinated electrical system. Early in your planning, contact your nearest General Electric Apparatus Sales Office. General Electric Company, Schenectady 5, N. Y. 662-49

Engineered Electrical Systems for the Process Industries

GENERAL ELECTRIC

marginal notes

WHAT TO DO ABOUT THAT HAZARD

Dangerous Properties of Industrial Materials, N. Irving Sax, assisted by L. J. Goldwater, W. B. Harris, J. H. Harley, J. J. Fitzgerald, and M. S. Dunn. Reinhold Publishing Corp., New York (1957), 1,467 p., $22.50.

An entirely rewritten and much expanded version of Sax's "Handbook of Dangerous Materials" has as its objective the provision of a quick, single safety reference for those involved in the manufacture, use, handling, storing, or shipping of hazardous materials.

The General Chemical Section of the book has been increased from about 5,500 entries to almost 9,000; this has been done by listing all commonly used isotopes and the nuclear properties and potential hazards of each, where available. The up-to-date nature of the work is further evidenced by the inclusion of an entirely new section on nuclear reactor safeguards as well as an expanded section on radiation hazards in industry.

For the industrial physician, there is included a section on industrial toxicology and one on allergic disease in industry.

For the safety man, there are sections on the control of industrial hazards, personnel protection, and air pollution, as well as articles on fire and explosion hazards and the storage and handling of dangerous materials.

A revised section on I.C.C. shipping regulations will be of interest to those who ship, receive, or transport dangerous industrial materials.

However, the chief value of this book, which should be on hand in every chemical plant, remains the General Chemical Section which gives detailed toxic hazard ratings for thousands of materials and which lists the fire, explosion, and disaster hazard potential of all chemical industrial materials for which such data exist.

—W.H.

Introducing the Peaceful Atom

Atomic Energy Facts. Issued by U.S. Atomic Energy Commission, Washington, D.C. Paper bound (1957), 216 p., $2.00.

One of the first in a series of books sponsored by the Atomic Energy Commission, this comprehensive summary of atomic activities was planned to serve as an introduction to nuclear operations and as a handbook for the industrial manager. It was intended also for the teacher, the writer, and others interested in the subject, and undoubtedly they will find here good source material for their respective assignments. With clarity and conciseness, and embellished by some eighty-six drawings, photographs, and tables, *Atomic Energy Facts*, devoted entirely to the peaceful uses of atomic energy, is a readable record of the history and development of a science which is fast becoming a commonplace in our everyday lives and which promises, according to the prescience of the Commission, to be a significant influence in our future.

An extensive index simplifies the effort of the reader and of research student to find the special phase of the atomic program he is interested in pursuing, whether it is processing operations, costs, design, or equipment.

The chapter headings, with their individual abstracts, are evidence of the complete coverage of nuclear technology and nuclear application in the United States. Here are typical chapter headings:

Production of Uranium and Thorium; Power Reactors, including nuclear power costs, basic reactor types, civilian power reactor development; Fuel Cycles, including solid fuel systems separation processes, radioactive waste disposal, and utilization of fission products; Reactor Materials, including heavy water, reactor grade graphite, beryllium, zirconium, research reactors; Radioisotopes, their availability, shipments, savings, and applications.

Other valuable information is contained in the eight appendices which cover basic principles of controlled thermonuclear programs; categories of restricted data available to access permit holders; depository libraries of U. S. Atomic Energy Commission; a bibliography; power reactor data tables; data for representative research reactors; gamma irradiation facilities; and a catalog of materials standards.

For this review and summing-up the Commission is to be congratulated.

—H.R.G.

Meet the Faculty

Chemical Engineering Faculties, 1957-58. Prepared by Chemical Engineering Education Projects Committee and Edited by Kenneth A. Kobe, Professor of Chemical Engineering, University of Texas. Office of the Executive Secretary, A.I.Ch.E., 25 West 45 Street, New York, 62 pages.

In this volume, the seventh in the series, 134 schools and departments of chemical engineering in the United States and Canada are listed. Included is such information as: accreditation by A.I.Ch.E.; student chapters, names of advisers or counselors; length of time required for undergraduate curriculum; details of evening classes; graduate work; number of degrees granted from September 1, 1956 to August 31, 1957; names of the faculties with their academic titles; names and titles of administrative officers and placement officers; and telephone numbers.

It should be noted that of the 122 American schools listed in this edition, ninety are accredited by A.I.Ch.E.

This compilation should be of inestimable value to industrial concerns, to the teacher, and to the student.

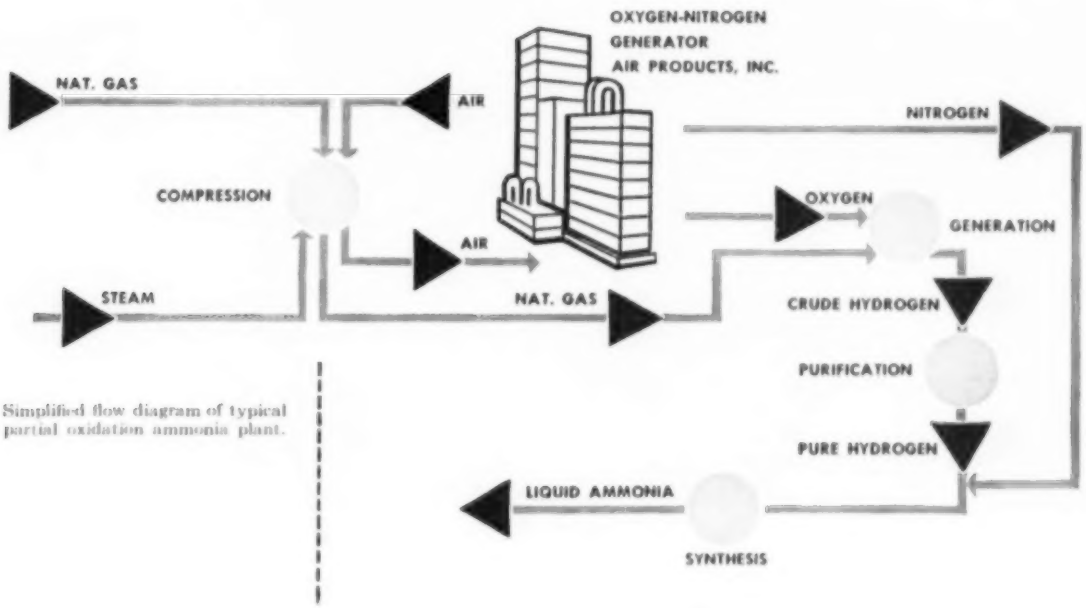
The committee wishes to thank the personnel of the Chemical Engineering Department of the University of Texas, Austin, for their assistance in a secretarial capacity and for their part in assembling the work.

High Temperatures

Study of Ultra High Temperatures, C. S. Stokes, Research Institute of Temple University, for Air Force Office of Scientific Research, November, 1956, 31 p. Order PB 121928 from OTS, U.S. Dept. of Commerce, Washington 25, D.C., $1.00.

Report describes a method which produced the highest flame temperatures obtainable from commercially available chemicals. Hydrogen cyanide, fluorine, and oxygen in combination produced a flame with a temperature of about 4,000° K.

Maximum "On-Stream" Time Lowers Ammonia Cost/Ton



Simplified flow diagram of typical partial oxidation ammonia plant.

...using Air Products Oxygen-Nitrogen Plant and Nitrogen Wash Process

Thanks to an increase in the amount of time that ammonia plants can spend "on stream", the dollar cost per ton is down. The increase is due to the dependability of Air Products low temperature air distillation, liquid oxygen pumping and nitrogen wash systems. Greater dependability means less down-time and increased production without increase in cost. One ammonia plant's oxygen-nitrogen generator, for example, set a record of 14 consecutive months without shutdown . . . permitting continuous production of ammonia for the entire period.

Air Products are specialists in processing low molecular weight materials at cryogenic temperatures. Our research and engineering activities, for ourselves as well as others, have developed a wealth of unique data, processes and equipment that may well point the way to profitable opportunities for you.

If your needs are to separate, purify, or liquefy gases . . . tell us your quantity, purity and pressure requirements . . . and let us suggest how this can most profitably be done at the low end of the temperature scale. Air Products, Incorporated, P.O. Box 538, Allentown, Pa.

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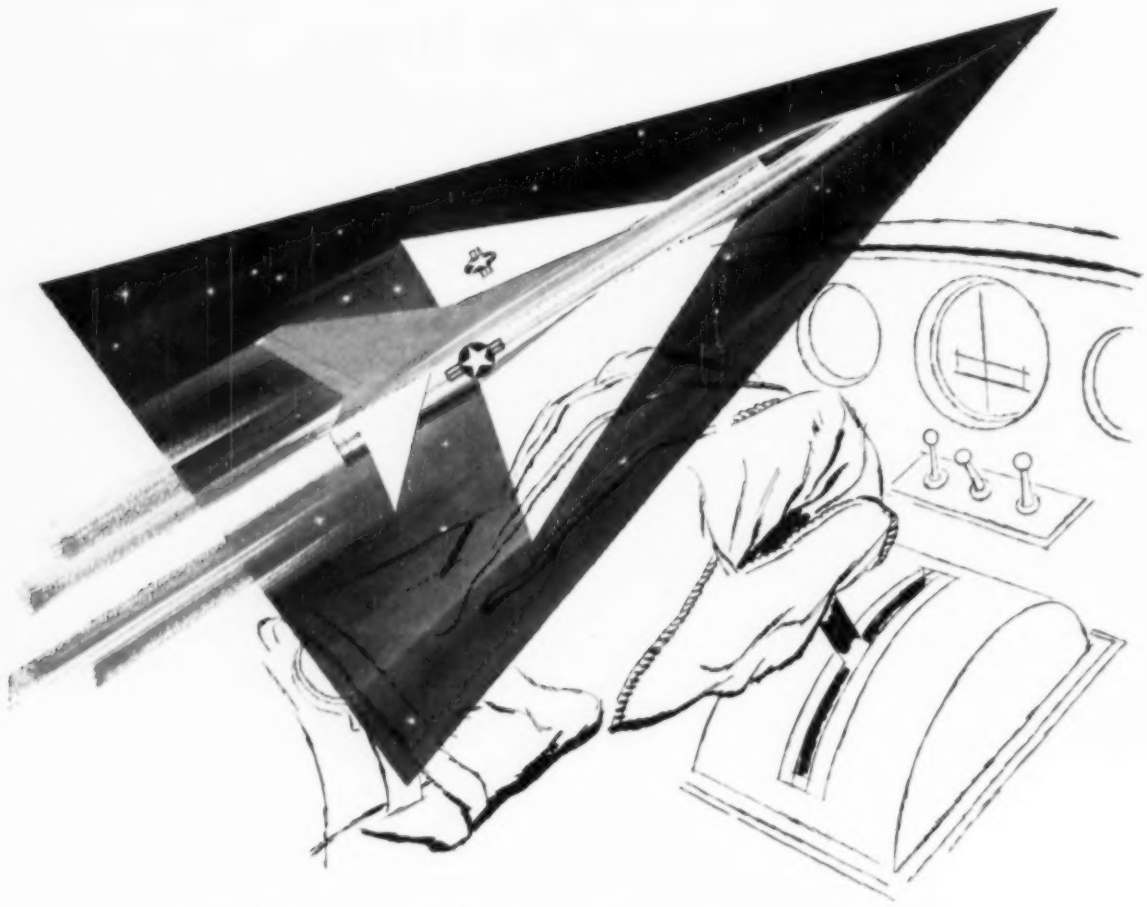
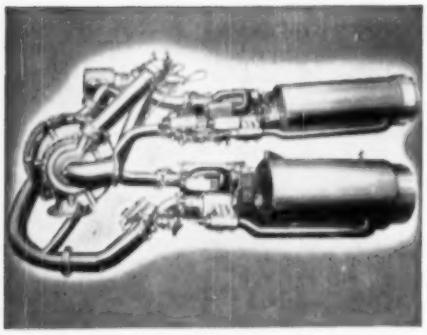


Higher and faster than ever before



World's first throttleable rocket engine is one of a group of Curtiss-Wright powerplants and missiles capable of several times the speed of sound.

The Curtiss-Wright Rocket Engine would fit under the hood of your car, yet delivers a thrust equal to the power that drives a Navy cruiser at high speeds . . . a thrust that has flown man higher and faster than ever before. And this record-breaking power is controlled, by the hand of the pilot, for the first time in history . . . doesn't burn itself out in ordinary rocket fashion.

The pilot can control his thrust through a wide range, start or stop it at will, conserve fuel or use it all in one prolonged burst. Operating at speeds near the thermal barrier he can explore the advanced problems of supersonic and hypersonic flight.

The Rocket Engine is one of a group of Curtiss-Wright powerplants and missiles capable of several times the speed of sound . . . a group that includes also the Ram Jet . . . and the HTV rocket which reaches supersonic speed a fraction of a second after launching.

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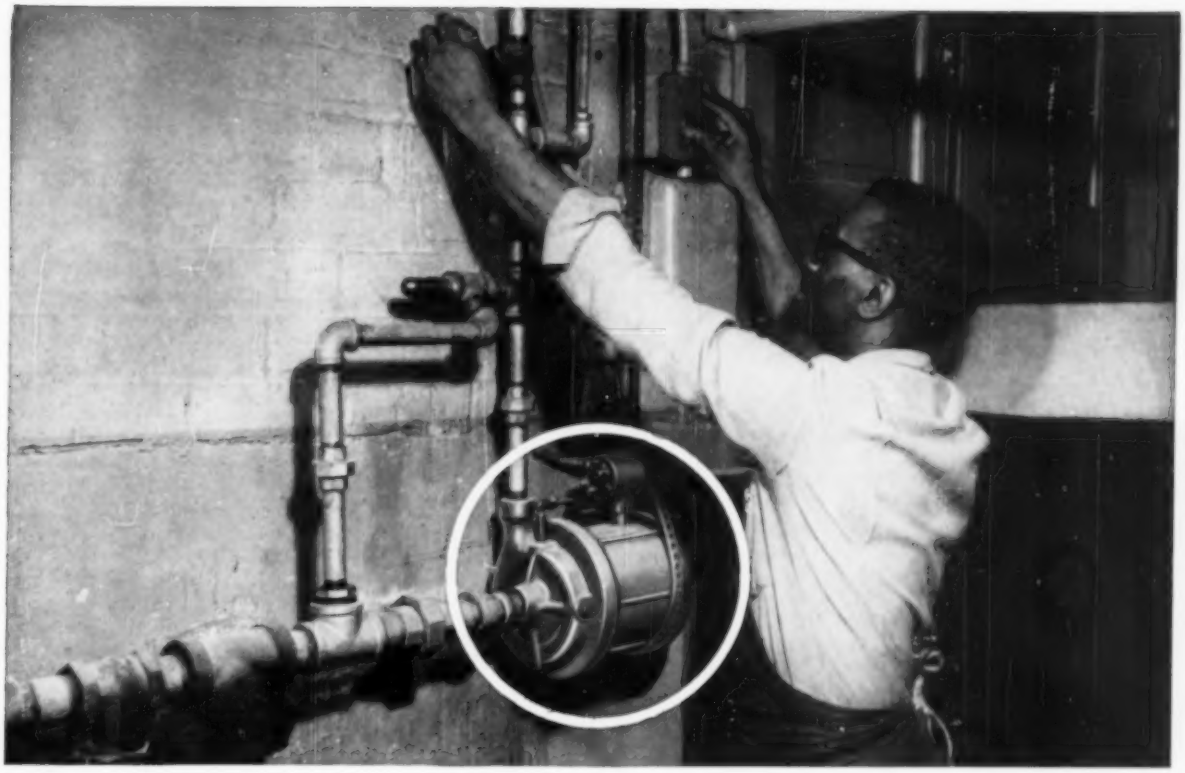


Chempump holds costs down

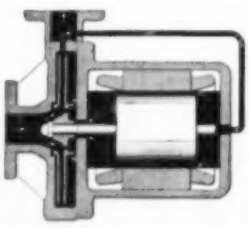
handling trichlorethylene at Argus Cameras

The explosion-proof *Chempump* shown above is one of two used at the Argus Cameras Division of Sylvania Electric Products, Inc., plant in Ann Arbor, Mich. to move trichlorethylene from storage to holding tanks.

Trichlorethylene—expensive and highly volatile—is used here at Argus for degreasing. It's hard to hold—seeps through conventional pump packing and dissolves packing lubricants. Leakage could mean continual maintenance expense, loss of costly trichlorethylene, and the hazard of explosion.

For Argus, *Chempump* eliminates these problems because it can't possibly leak—has no seals, no stuffing box, no packing. Simplicity of design reduces maintenance to an occasional inspection and replacement of bearings. External lubrication is never required . . . bearings are constantly lubricated by the pumped fluid itself.

You have much to gain through leakproof fluid handling with Chempump in your own processing operations. For details, write to Chempump Corporation, 1300 East Mermaid Lane, Philadelphia 18, Pa. Engineering representatives in over 30 principal cities in the United States and Canada.

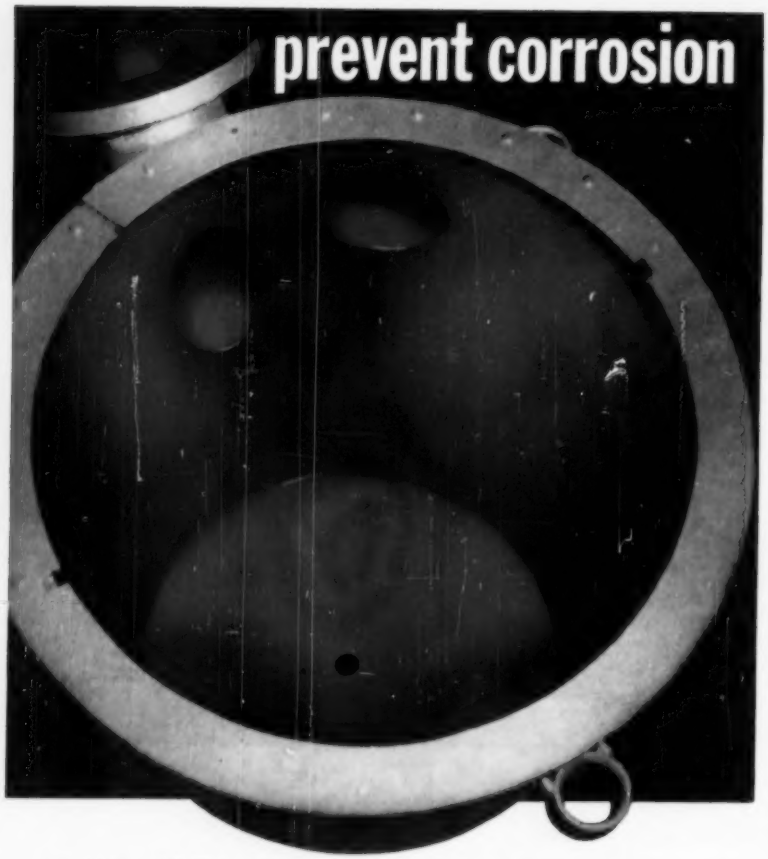


Chempump combines pump and motor in a single, leakproof unit. No shaft sealing device required.

U.L. approved. Available in a wide choice of materials and head-capacity ranges for handling fluids at temperatures to 1000 F. and pressures to 5000 psi.

Chempump

First in the field...process proved



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From a reactor pot to a tank truck—KEL-F* Laminate linings offer the way to make any ordinary equipment and piping extremely resistant to acids, alkalies, oxidants and solvents at temperatures up to 350°F—and at reasonable cost.

KEL-F Laminate, Garlock style No. 9574, is a durable, shatterproof, abrasion resistant, chemically inert fluorocarbon plastic, bonded to a glass-cloth backing for maximum adhesion. It is readily cemented over any contour and to any material of construction—metal, wood, concrete, etc. KEL-F being a thermoplastic resin, seams may be "welded", on the job by the thermal pulse technique, into a continuous chemically-impregnable lining.

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Write for Bulletin AD-152.

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about our authors

Included in this issue of *CEP* is the last (but by no means least) article of our series on Direct Operating Labor Costs in Chemical Industry. This month's article, "Estimating D. O. L. for New Manufacturing Processes," is by **R. S. Wobus,** technical production manager in the Organic Chemicals Division of Monsanto in St. Louis, an old hand in this area of chemical engineering. He has worked at a number of Monsanto plants on production problems involving plant expansion, new product evaluation, process improvements, etc.

Robert R. Freeman, author (with **T. R. Dashiell, M. A. Auro, I. Oshrine,** and **R. F. Smith**) of the paper "Drying of Viable Biological Materials by Solvent Extraction and Azeotropic Distillation" in this issue, is a staff engineer at the Army's Fort Detrick, Maryland, Biological Warfare Labs. Commissioned in the Chemical Corps and assigned to Detrick during World War II, Freeman returned after the war as a civilian to "pick up where he left off," is now planning, coordinating, and evaluating aspects of the Army's research program dealing with process design and general investigations in the field of bio-engineering unit operations.

Also at Fort Detrick is **Ira Abelow,** who with **E. W. Flosdorf** (of F. J. Stokes Machine Co., Philadelphia) wrote the article on freeze drying in this issue. Freeze drying techniques, which involve removing water in the frozen state at temperatures as low as —100° F., are responsible for successful drying of blood plasma, vaccines, antibiotics, and other pharmaceutical preparations. Recently the process has had pronounced success with heat-sensitive foodstuffs such as seafoods, steaks, and various juices.

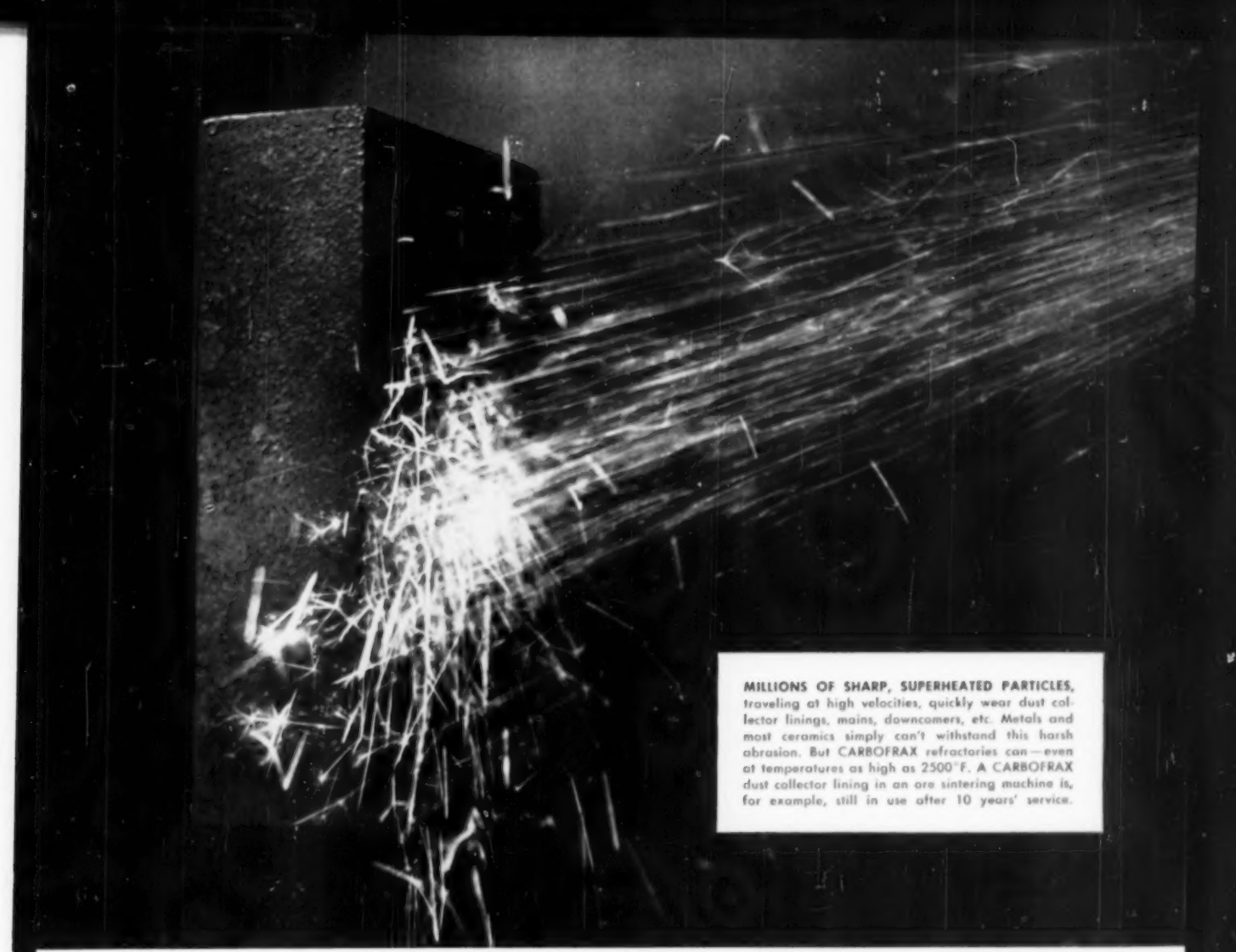
Another drying expert, **Hoyt Chaloud** of Procter & Gamble, gives us this month (with co-authors **J. B. Martin** and **J. S. Baker**) the article on spray drying of (you guessed it) detergents. Chaloud is at present in charge of detergent development for the Product Development Division of P & G, says that the present article

(Continued on page 36)

Wobus

Freeman

Chaloud



MILLIONS OF SHARP, SUPERHEATED PARTICLES, traveling at high velocities, quickly wear dust collector linings, mains, downcomers, etc. Metals and most ceramics simply can't withstand this harsh abrasion. But CARBOFRAX refractories can—even at temperatures as high as 2500°F. A CARBOFRAX dust collector lining in an ore sintering machine is, for example, still in use after 10 years' service.

Refractories . . . to resist abrasion

Exceptional resistance to abrasion—whether caused by tiny gas-borne particles or sliding steel billets—is one of the most useful properties of several of Carborundum's unique refractory materials. For example, when used in the exhaust lines of gasoline catalytic cracking units in temperatures ranging up to 1200°F, these refractories lasted 3 years, as compared to alloy rings which lasted for 6 months.

And when abrasion is combined with higher temperature, the exceptional resistance of these super refractories becomes even more apparent and useful. As skid rails in furnaces which heat 6-lb. billets to 2250°F—pushing 250 slugs an hour—CARBOFRAX® silicon carbide refractories need one-third the replacement, one-third the labor and one-third the down-time of ordinary rammed chrome ore hearths. Other successful applications include: dust collectors, gas scrubbers, transfer pipe lines, hydro cyclones and process equipment parts, to name but a few.

Many applications call for other properties in combination with wear resistance. Among Carborundum's many materials are refractories that also offer excellent heat shock resistance with sufficient hot strength to withstand 25 psi at 3128°F. Others provide unique resistance to corrosion as well as abrasion. These properties are but a few of those to be found in super refractories pioneered by Carborundum. Among them, you are almost certain to find answers to your refractory and high-temperature problems. For help, fill in and mail this coupon:

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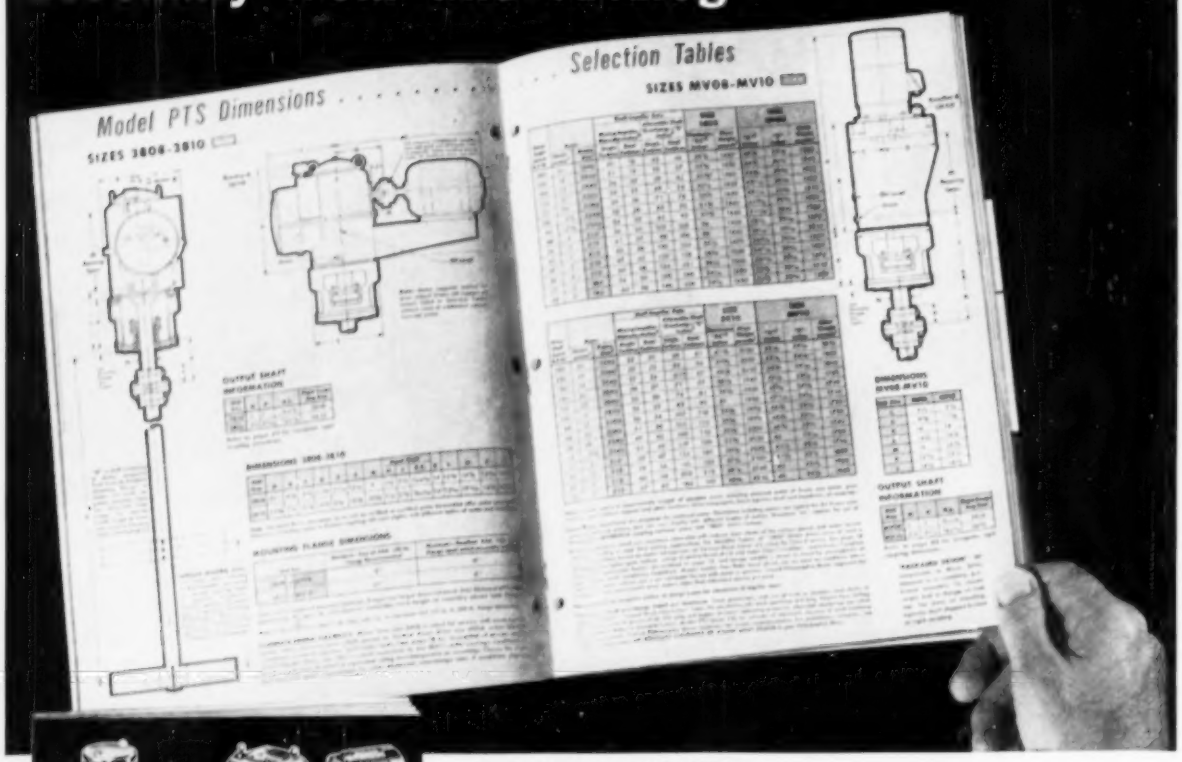

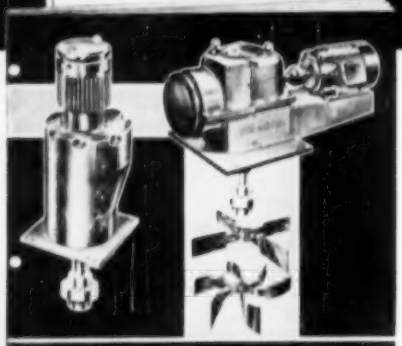

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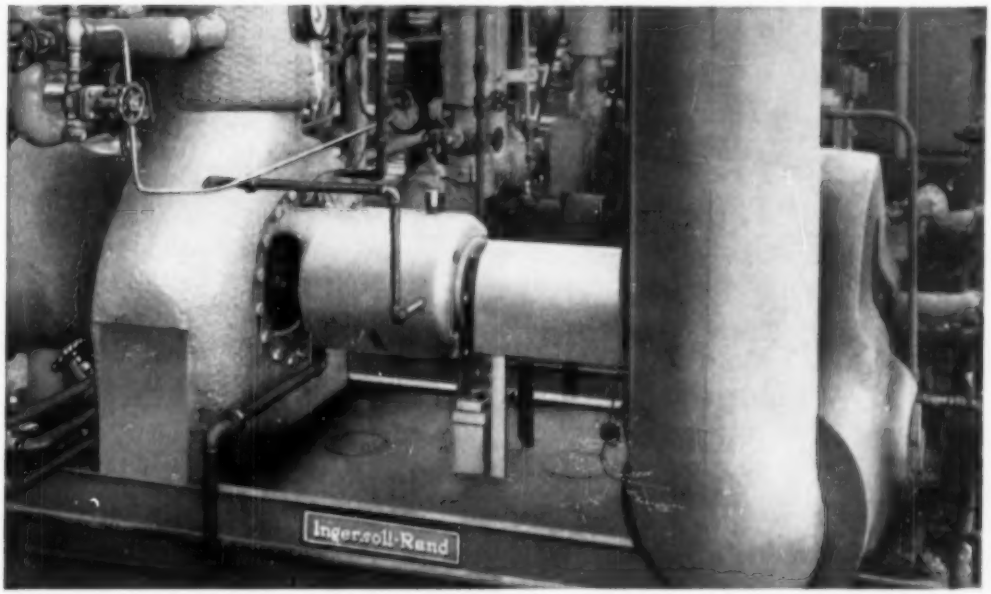
THIS INGERSOLL-RAND CHEMICAL PUMP MUST STAY ON THE JOB

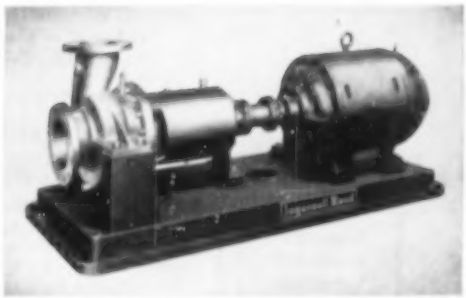


- **2 years of continuous operation**
- **Not a moment's down-time**
- **No spare pump**

This Ingersoll-Rand chemical pump is a key pump in the urea process at the Grace Chemical Company's plant in Woodstock, Tennessee. Here, the process is entirely dependent upon the pump. On stripper recirculating service, it is handling 4600 gpm of urea solution and oil at a temperature of 246° F, total head 117 ft. To withstand corrosion by the liquid handled, the pump parts are made of corrosion-resistant stainless steel.

In 2 years of continuous operation, without a spare, this pump has never been down for maintenance. Here is proven dependability in "round the clock" service.

If you are faced with a pumping problem, Ingersoll-Rand is ready to help you solve it. I-R manufactures a complete line of single and multi-stage centrifugal pumps in both horizontal and vertical designs. For further information just call or write your nearest I-R branch office.



View of class CSFL pump of the same design as shown with lagging in the installation view above. Available in 6, 8 and 10-inch sizes, they are designed for handling large capacities of hot or cold liquids at temperatures to 800° F.

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Ask for Technical Bulletin CE-56.

ABBREVIATED TABLE OF CHEMICAL RESISTANCE

ACIDS		BASES		MISCELLANEOUS			
Acetic 50%	S	Ammonium Hydroxide 28%	S	Ethyl Alcohol	S	Carbon Tetrachloride	S
Chromic 25%	S	Sodium Hydroxide 50%	S	Methyl Ethyl Ketone	U	Plating Solutions	S
Hydrochloric 38%	S	HALOGENS		Gasoline	S	Photographic Solutions	S
Hydrofluoric 50%	L	Sodium Chloride Sat.	S	Mineral Oil	S	KEY: S—Satisfactory	
Nitric 20%	S	Ferric Chloride	S	Animal Oil	S	L—Limited to certain applications	
Sulphuric 50%	S	Sodium Hypochlorite 5%	S	Vegetable Oil	S	U—Unsuitable	
Sulphuric 98%	S			Phenol 10%	S		
				Chlorine 5%	L		
				Alum	S		

ACE processing equipment of rubber and plastics

AMERICAN HARD RUBBER COMPANY

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DIVISION OF AMERACE CORPORATION

About our authors

(Continued from page 32)

is the result of a series of "brainstorming" meetings with company personnel intimately acquainted with spray drying and its problems. Martin and Baker were responsible for organizing and evaluating the information thus obtained, while Chaloud and others put the new ideas to test in pilot plants and factory units.

Part 2 of the Sorption Processes series, which started last month with reviews by Monet and Lapidus, includes in this issue reviews by symposium chairmen (Baltimore) Selke and Winger. **W. A. Selke,** director of research for Peter J. Schweitzer, Inc., Lee, Massachusetts, headed the session on Granular Processes—Ion Exchange. Formerly on the faculty of Columbia University, New York, Selke was involved while there with AEC-sponsored projects in the ion exchange field.

Alvin G. Winger, in the Resinous Products Division of Rohm & Haas

Abelow

Selke

Winger

Bulkley

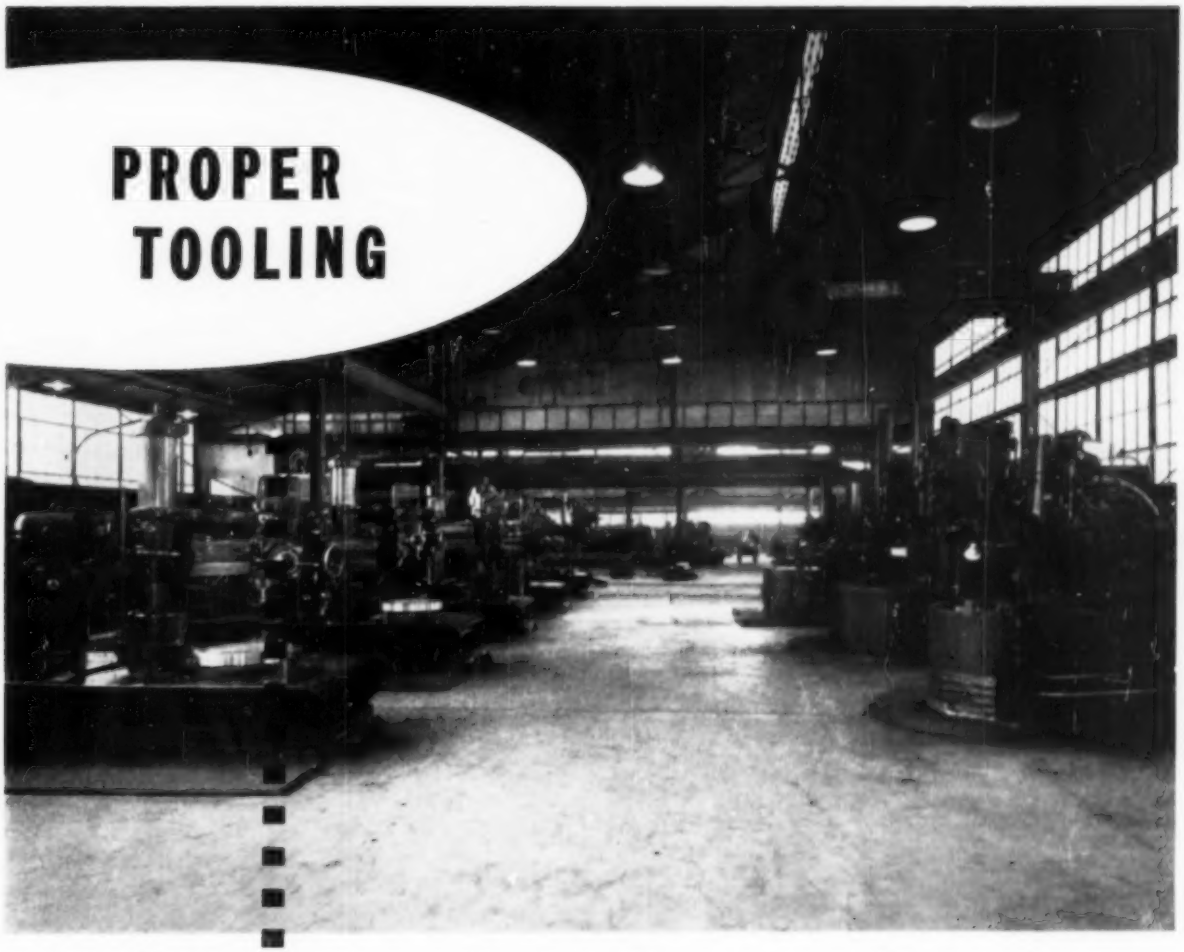
Randall

Piret

at Philadelphia, was chairman of the Membrane Processes symposium at the Baltimore A.I.Ch.E. meeting in September. Author of numerous articles in the field, Winger has written on fundamental membrane properties, their application in electrodialysis and electrochemical processes, has published calculations on performance of a multiple membrane electrodialysis cell based on the properties of the membranes and the solutions.

Looming large in this issue is the fine article "Destruction of a Large Refining Unit by Gaseous Detonation" by Standard of Indiana men **R. B. Jacobs, W. L. Bulkley, J. C. Rhodes,** and **T. L. Speer.** Jacobs, who has a Doctorate in Physics from Caltech, is a specialist in applied physics and instrument design, works in the Engineering Research Department. Bulkley, also in the Engineering Research Department, specializes in fluid mechanics and heat processes, including combustion. A Utah and

(Continued on page 42)



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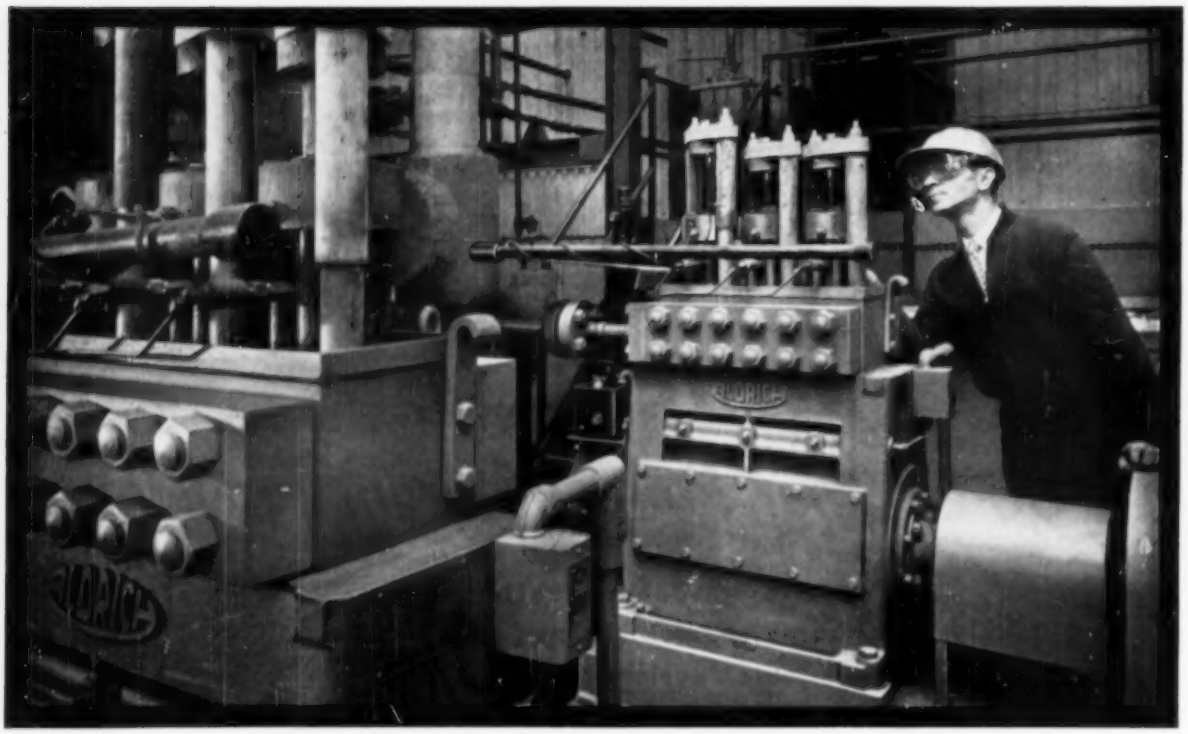
Maintaining a controlled flow of liquid ammonia at high pressures, 24 hours a day.

At the Vicksburg, Miss. plant of Spencer Chemical Company, ammonia production demands two things of pumps: (1) 24-hour, 7-day-week operation and (2) continuous flow of controlled volumes of liquid ammonia at high pressure.



How Spencer licked the problem: When Spencer began outlining construction plans in 1951, company engineers specified two Aldrich Direct Flow, $\frac{3}{4}$" x 3" stroke Triplex Pumps. These were scheduled to be used for alternate 30-day periods. According to company spokesmen, nearly four years of service have proved these pumps to be efficient and capable of durable service.

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We'll be glad to send you full information on Aldrich Pumps and their advantages to you. Simply write Aldrich Pump Company, 20 Gordon Street, Allentown, Pa.

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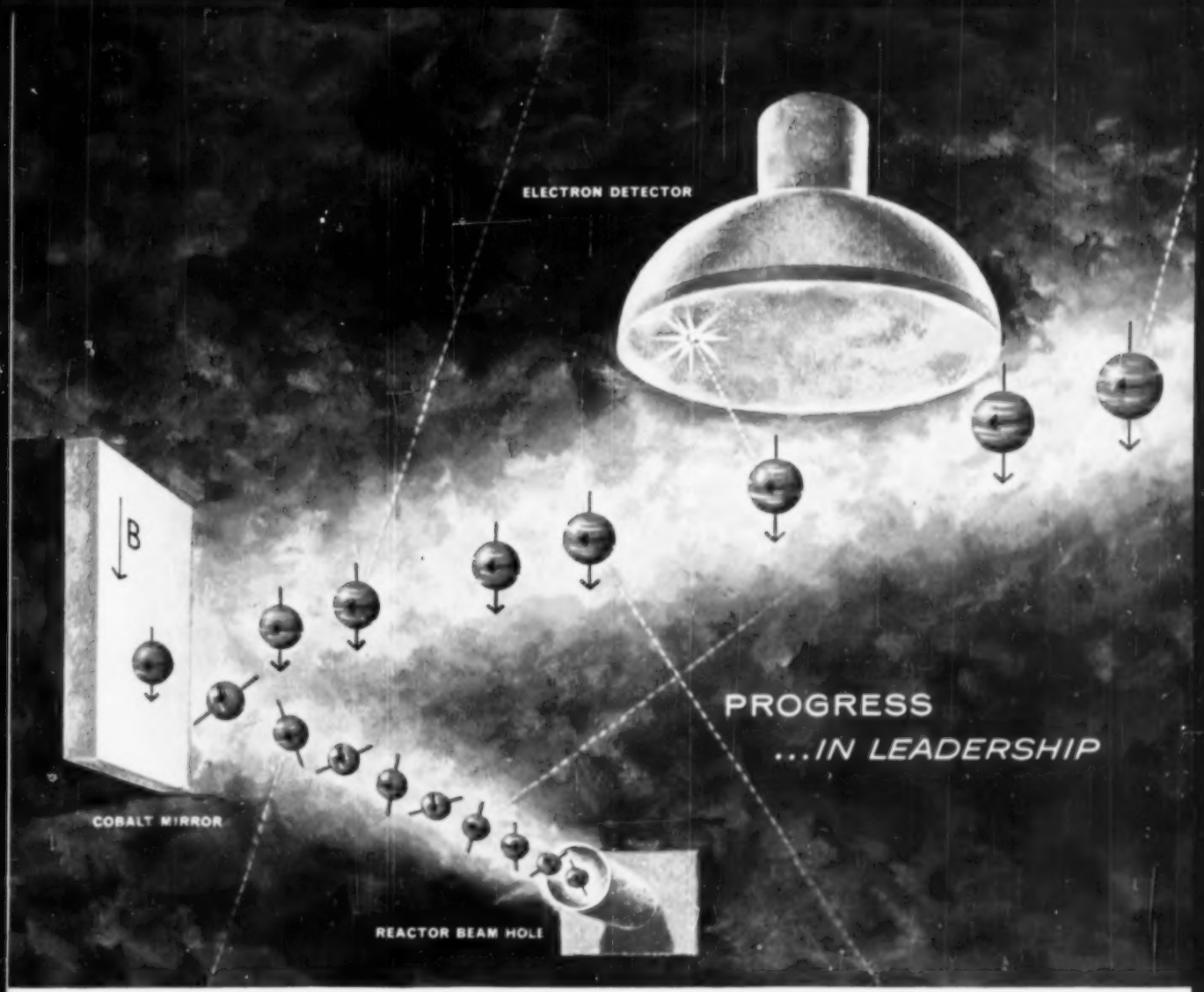

measuring the free decay of polarized neutrons

A fundamental test of the various theories of beta decay which have been inspired by recent parity experiments is obtained from the quantitative measurement of the spatial asymmetry of the beta particles emitted in the decay of free polarized neutrons.

For these measurements, neutrons with identical spin directions were selected from a neutron beam from Argonne's CP-5 research reactor by reflection from a magnetized cobalt mirror. This technique for obtaining polarized neutrons was conceived and developed by Argonne scientists.

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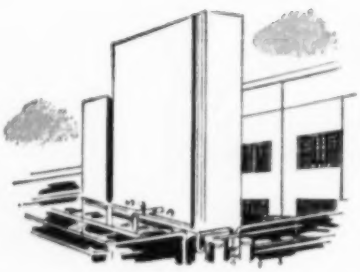

LONG THE BANE OF many chemical processes, carbon monoxide has suddenly become one of the most valuable raw materials of the ever-growing plastics and allied industries. More important still is its method of production by low-temperature gas separation, in which techniques perfected by Air Liquide during the past 50 years have resulted in unprecedented efficiency, tremendous economies and maximum purity.

Leading this highly specialized field in the United States, Air Liquide low-temperature gas separation plants, the first to be built in this country for the production of pure CO, have recently been completed in four widely separated locations, and a fifth is under construction.

Our entire technical and manufacturing staff, including design, process, project and mechanical engineers, backed by a half century of world-wide experience, is at your service to assist you in applying low-temperature technology to your particular needs — whether your product requirements are carbon monoxide, oxygen, nitrogen, hydrogen or other gases, or a solution to purification problems.

We shall be glad to consult with you regarding cost analyses and technical aspects in the design and manufacture of complete plants or components especially fitted to your needs. Write today for complete technical information on our CO plants.

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Liquid oxygen, vital to today's rocket engines and many types of missiles, was being produced by LINDE as long as 25 years ago. In fact, LINDE has been supplying oxygen to industry for more than 50 years. LINDE pipes oxygen directly to industrial users from nearby oxygen plants built and operated by LINDE. The user makes no capital investment, and pays only for the oxygen consumed —at a price guaranteed by LINDE.

LINDE also developed methods for transporting liquid oxygen efficiently, in large and small amounts, at 300 degrees below zero F. You can get LINDE oxygen in just the quantity you need, at the exact time and place you want it, as a liquid or a gas.

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Liquid oxygen from LINDE's DRIOX oxygen units is teamed with liquid fuels to propel missiles and rocket planes.

Difficult batching problems solved by Autoweightion*

- *All types and combinations of materials successfully handled*
- *High degree of accuracy obtainable*
- *Thayer Scale Flexure Plate Leverage System guaranteed accurate for life*

Fig. 1

The development of the Thayer Autoweightion System for controlling materials processing systems has opened the door for many hitherto impractical batching operations. For instance, several different flushing materials (flooding powders) can now be handled without leakage by a tipping bucket weigh hopper (Fig. 1) controlled by a series of different range Thayer weigh beams.

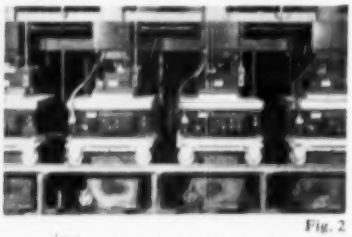

Fig. 2

Thayer individual batching scales can be used to furnish preweighed charges which may be varied in weight to suit the formula. The system shown (Fig. 2) can be furnished to allow positioning under various bins or feeders so each scale will preweigh a given weight charge and discharge it to a conveyor belt or to a mixer for further processing.

Fig. 3

Where many ingredients are to be handled and there is a factor of space saving and a minimum amount of equipment, it is possible to utilize an accumulative batching scale which can either be fixed or moveable as shown (Fig. 3). This unit will have a large weigh hopper sufficient to accommodate the total weight of any number of ingredients desired to be accumulated. To secure accuracy in various weight ranges, the weighing of each individual ingredient will be controlled by its own weigh beam on the scale and the various ingredients will be weighed into the common weigh hopper in turn at the prescribed formulated weight.

Difficult to handle materials, such as hot tar, high viscosity liquids and other such ingredients which leave a residue in the weighing vessel can be handled in a loss-in-weight manner by first precharging a vessel to any weight and then withdrawing a known amount for the desired charge (Fig. 4). By this means the remaining tare weight within the hopper will not affect the weight of the next discharged load. Such a unit can be used either as a single batching scale or as an accumulative batching scale discharging in a loss-in-weight manner.

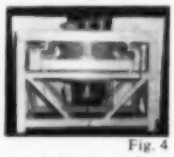

Fig. 4

Engineered solutions such as these have put Thayer batching systems into many of the best known processing plants in North America. Thayer builds a complete line of feeders interlocked with Thayer Scales. Remote controls, adding machines and chart indicators are also supplied. Please write us about your batching problems.

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13 Thayer Park, Pembroke, Massachusetts

About our authors

(Continued from page 36)

M.I.T. chem engineering graduate, Bulkley did a good job on the Technical Program Committee for A.I.Ch.E.'s Annual Meeting in Chicago earlier this month. Rhodes is senior project supervisor in Standard's Instrument Development Group; Speer, civil engineering grad from Armour and Illinois U., is now senior supervisor in Engineering Research.

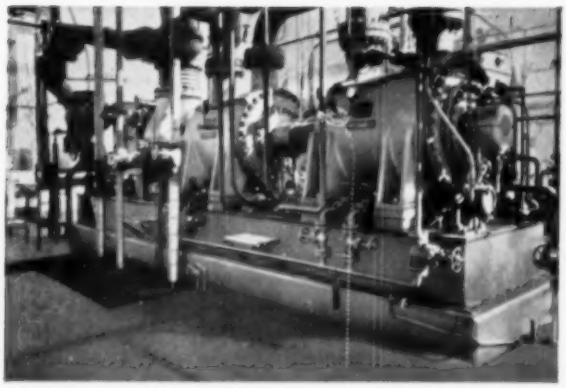
Edgar L. Piret, who writes the first of two articles reporting observations while recently in the Soviet Union, is well known to *CEP* readers. Prof. of chem engineering at the U. of Minn., consultant to Minnesota Mining, and director of Minnesota's Peat Project (for which he went to USSR), Ed manages to find time to write papers on continuous stirred reactors and to serve on Institute committees. In the present article, Ed gives his general impressions. Next one will take us into three major chemical engineering institutes, reporting on talks with leaders of the profession in the USSR.

Gilbert P. Monet, through whose considerable efforts the *Sorption Processes* articles came to be written, has been developing the concept of this common basis of similarity for adsorption, dialysis, and ion exchange since 1949. A research project engineer in chemical engineering at DuPont, Gil worked on ion exchange during the latter days of the Manhattan Project. After some post-war graduate training at M.I.T., he returned to DuPont in 1947 and plunged again into what he now advocates be called the *sorption processes*.

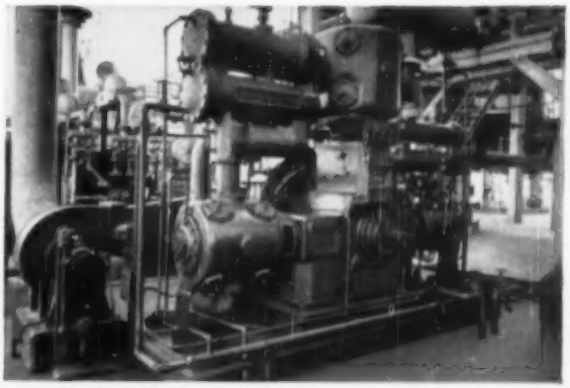
Joseph L. Gillman, Jr., who joins the editorial staff of *CEP* this month as *Contributing Editor—Washington, D.C.*, has been authoring dispatches from the Nation's Capital for several months. Immediate past-president of the D.C. local section of A.I.Ch.E., Joe has his own consulting engineering practice, serving manufacturers of industrial products. Joe's many friends are used to seeing him in good company (see picture), as was recently the case when he (as toastmaster) introduced General Gruenther at the recent 52nd Annual Dinner of the Washington Society of Engineers.

At Amoco's No. 1 Texas City Ultraformer . . .

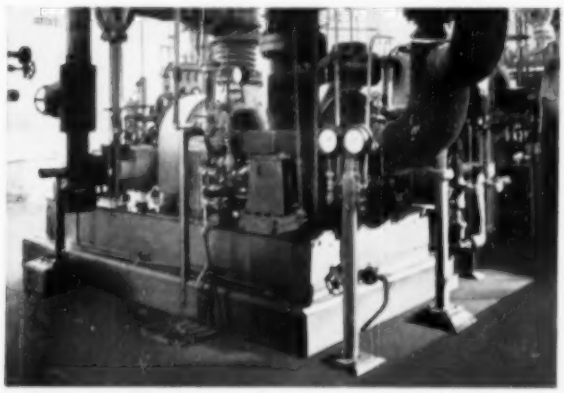
Ingersoll-Rand compressors handle all air and gas requirements



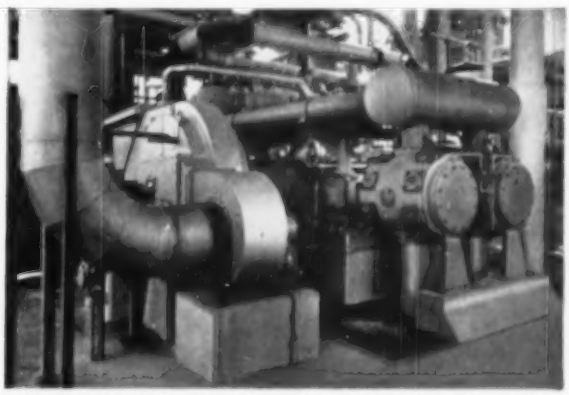
Hydrogen Gas is recycled by these two steam-turbine-driven Ingersoll-Rand vertically split centrifugal compressors arranged in series tandem. Final discharge pressure is 470 psi.



Inert Gas is handled by this TVH electric-motor-driven three-stage reciprocating compressor. Unit is rated at 500 psi.



Hot Gas at 680°F is circulated by this single-stage Ingersoll-Rand centrifugal that handles 3620 cubic feet per minute.



Compressed Air at 275 psi is furnished by this 700-hp Ingersoll-Rand HHE reciprocating compressor.

I-R centrifugal and reciprocating compressors also selected for No. 2 Ultraformer.

WHEN Amoco's No. 1 Texas City Ultraformer went on the line in February 1955, it was served by the Ingersoll-Rand centrifugal and reciprocating compressors shown above. For the No. 2 Ultraformer, scheduled to go into operation later this year, I-R centrifugal and reciprocating compressors were again specified to handle all air and gas requirements.

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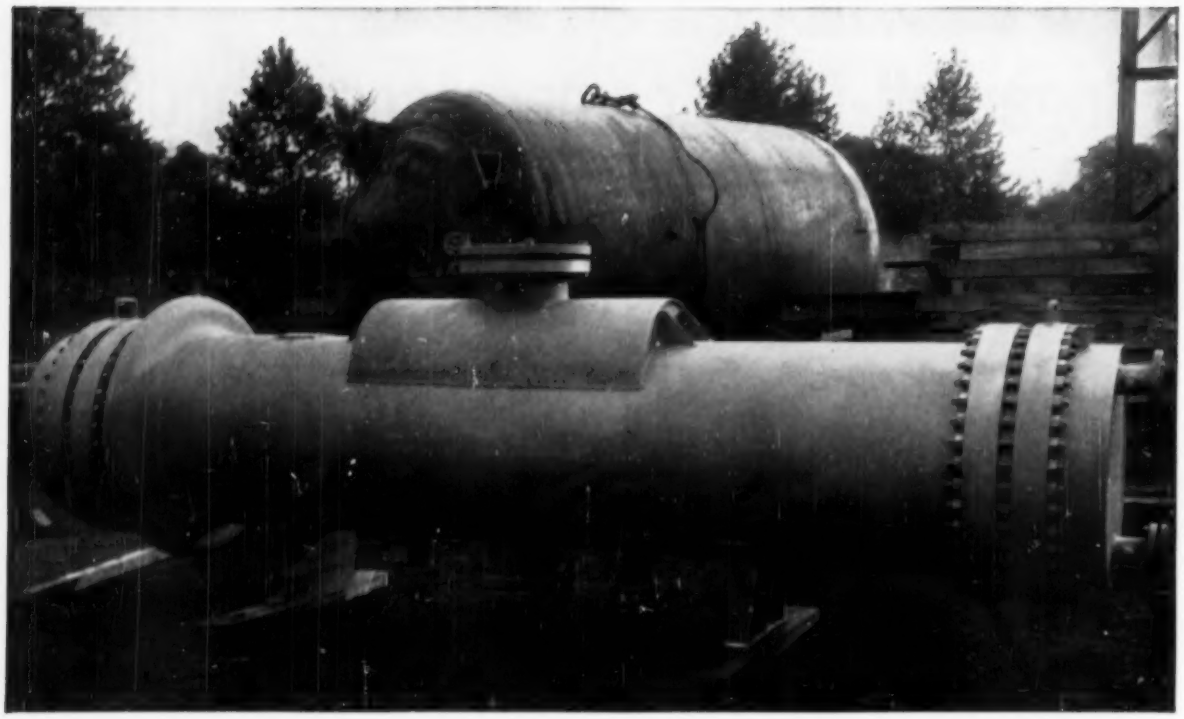
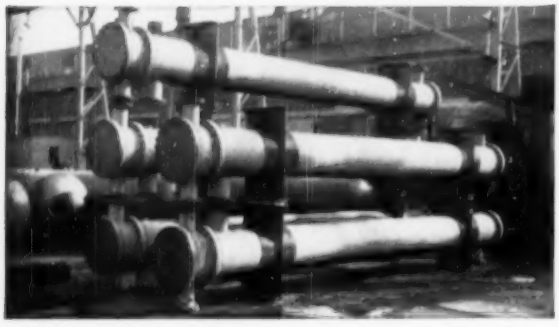
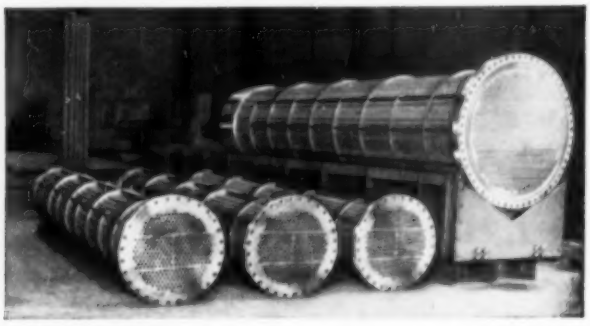


Inconel and stainless heat exchanger built for Barrett Division, Allied Chemical & Dye Corporation. Shell Diameter: 30". Tube Length: 12' 0". Tubes: 1" O.D. x 14 ga. Tube Sheet Thickness: 2". Materials: Inconel shell, tubes, tube sheets. Stainless steel heads, Type 316L.

Stainless steel plus nickel alloy equals corrosion-resistant heat exchanger by Downingtown



Aluminum bronze for these five coolers saved the customer 25% on equipment costs, assured corrosion resistance. Each fixed tube sheet unit is 20" in diameter x 20' tube length. Each has 282 aluminum bronze tubes ¾" O.D. x 12 ga. Centrifugally cast channels. Design pressure: 150 p.s.i. on both shell and tube sides.



Stainless steel Type 304 is the material for these four tube bundles. The large one fits a 37" shell, has 1225 stainless tubes, ¾" O.D. x 14'0" long. Tube sheet: 2⅞" thick. Baffles: ⅜" thick. The other three bundles are 22" in diameter; each contains 352 tubes ¾" O.D. x 16 ga. x 12'0" long. Tube sheets: 1¾" thick. Baffles: ¼" thick. All stainless steel.

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HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

More than one scientist has remarked in recent weeks that, in sending up the Sputnik, the Russians have in effect achieved a "Pearl Harbor"—which is to say that they have won a surprise scientific victory comparable to the first military victory of Japan in the last war.

The analogy is not a bad one. It has certainly created some panic and hysteria in private and in government circles and an atmosphere that should generate "crash programs" in defense. On the favorable side, it may mean that the country has been aroused from lethargy and will now bend every effort to catch up—as happened with the war effort in 1940.

Scientific Manpower

A basic long range problem confronting the engineering profession, industry engaged in defense, and the government is that of scientific manpower and of how to correct what now appears to be a serious lag in teaching and in graduating trained engineering and scientific personnel.

A suggestion has been made that the government should subsidize the education of graduate students working for their masters degrees in order to offset the trend for men to run out of the schools and into industry for financial reasons before their training is complete. The need now in the defense program is for more men with a higher degree of proficiency in the newer and still rather esoteric realms of science and technology. One difficulty in obtaining this is a shortage of teachers, some of whom might also have to be kept from or taken back from industry.

A government program of this sort would cost only a comparatively few millions—a drop in the bucket compared to the billions that have been appropriated for defense projects. Of course the mechanics of any plan of this sort might entail a number of difficulties. One possibility that has been disturbing leaders in education is that Congress might be stampeded into some sort of mobilization of scientists which could entail controls that would be irksome and possibly inefficient.

It is in any event probably time that more attention be given to the urgent needs of defense and that less emphasis be placed and less manpower devoted to producing better color television, bigger tail fins on cars, and more omniscient household gadgets.

Nuclear Developments

The excitement over the missile program has obscured in the public eye the not too encouraging events that have been taking place in the nuclear field. While indications are that the United States is apparently on a par with Russia (and possibly ahead in the production of bombs and of new types of bombs), the nuclear power business seems to have bogged down badly.

The Atomic Energy Commission has cancelled contracts for two nuclear power projects and has given indication that it does not want the development of many more uranium ore projects. Many big industrial firms that rushed into the "atomic business" over the last year or so with emphasis on reactor building are now quite disillusioned. Losses instead of profits have been the order of the day, and many firms are cutting down scientific staffs and laying off employees in this field. One firm that planned important new facilities for making fuel elements has decided not to go ahead because the business is not there, because foreign competitors have been picking up the business abroad, and because the controls set up by the AEC make it difficult to operate.

But nuclear developments for peacetime can still be a propaganda weapon abroad approaching the satellites in importance. It would appear that this situation should be examined lest we fall behind in exploring another major scientific frontier.

The Business Front

On the business and economic front there are as many conflicting cross-currents as in the scientific arena. The Federal Reserve Bank has apparently reversed its tight money policy in an effort to halt the business downtrend, although other officials in Washington bravely assert that everything is all right. However, business indices continued to decline in November. The Federal Reserve index of industrial activity continued down. Freight car loadings, probably the plainest reflection of what is actually happening in business, are running 15 per cent below the 1956 level, showing the sharpest decline in about three years.

The big puzzle is whether or not the Federal Reserve can really turn business up when it starts down. There have been periods of recession when money was cheap and abundant, so it cannot be concluded that money policies are necessarily the only—or even the main—key to industrial activity. In any event, action to change money problems will take some time before it will be reflected in business. Meanwhile, another cross-current is long range inflation, which seems almost a certainty with the need for defense spending and perhaps for an unbalanced budget, but when this may take hold in a manner to stimulate business is a puzzle plaguing industrialists.

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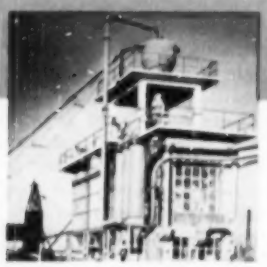

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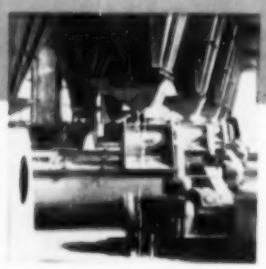

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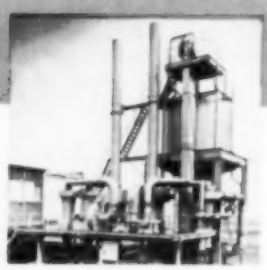

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CEP

opinion and comment

WITH ALL SPEED, MR. K.

Recently, a California research executive,* addressing a meeting of national security-minded industrial men, cited some alarming facts about the Soviet Union's efficiency in translating and disseminating the technical and scientific information emanating from this and other western nations.

"For years, it has been common knowledge in this country that the Russians have an elaborately organized effort to obtain the proceedings of our technical meetings, and articles contained in publications from our technical presses," reported Mr. Carter.

"This information is rushed to the Soviet All Union Institute of Scientific and Technical Information. Here, information is analyzed, abstracted, elaborately cross-indexed, and distributed to appropriate scientific personnel.

"This is no leisurely operation, carried on in bureaucratic surroundings. It is a continuous crash program. It has paid off by making available to Russian scientists a vast storehouse of scientific information which they can retrieve at will.

"We in the United States have no such effective facility for collecting and disseminating [Russian] scientific information. In fact, the Russian agency is so thorough that a member of our own National Science Foundation has stated that the most efficient and authoritative means for improving United States coverage of scientific happenings is to translate directly from the Russian abstract journal dealing with a particular science."

Carter calls for a revision in our thinking and a willingness to accept scientific achievements of the Russians.

"We must give immediate attention to the problem of upgrading our own storehouse of scientific information," warned Carter, "and we should proceed quickly to establish a facility for storing and retrieving technical literature from all over the world."

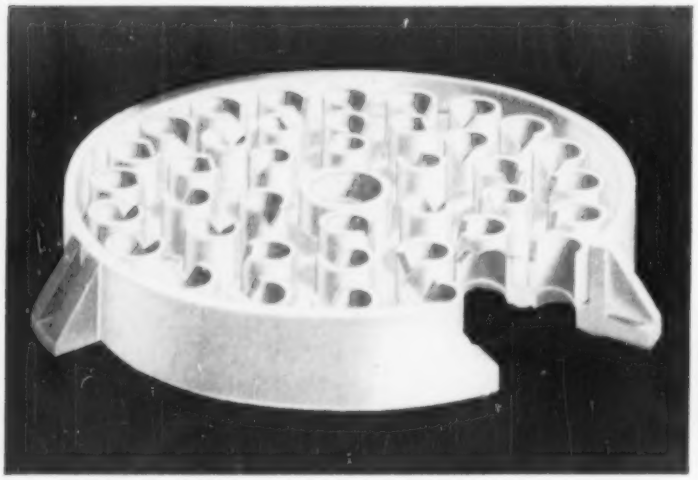
We now have such a program under way, according to a recent announcement by Murray Snyder, assistant secretary of Defense, who confirmed that the responsibility for setting up such a system relative to the Russian literature has been accepted by the new special assistant to the President for Science and Technology, James R. Killian, Jr.

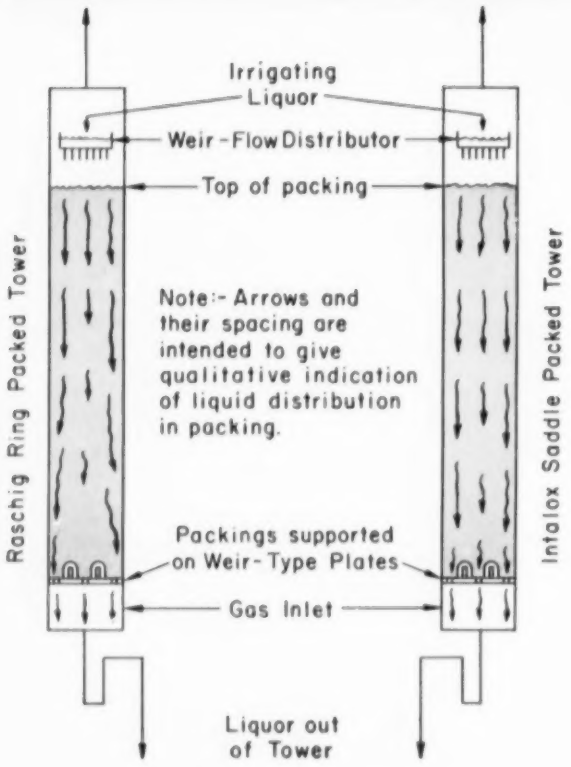
Undoubtedly, Mr. Killian will have a host of other problems and projects facing him in his new capacity. There will surely be times when he will have his attention distracted from this particular project. Because, however, he is noted as an editor as well as an administrator, he may feel so deeply the information needs of our technologists, that he will push this particular project to the limit. We certainly hope he does.

J.B.M.

* E. Finley Carter, director of Stanford Research Institute, addressing a meeting of the National Security Industrial Association.

How to achieve better liquid distribution in PACKED COLUMNS




Irrigating Liquor
Weir-Flow Distributor
Top of packing
Note:- Arrows and their spacing are intended to give qualitative indication of liquid distribution in packing.
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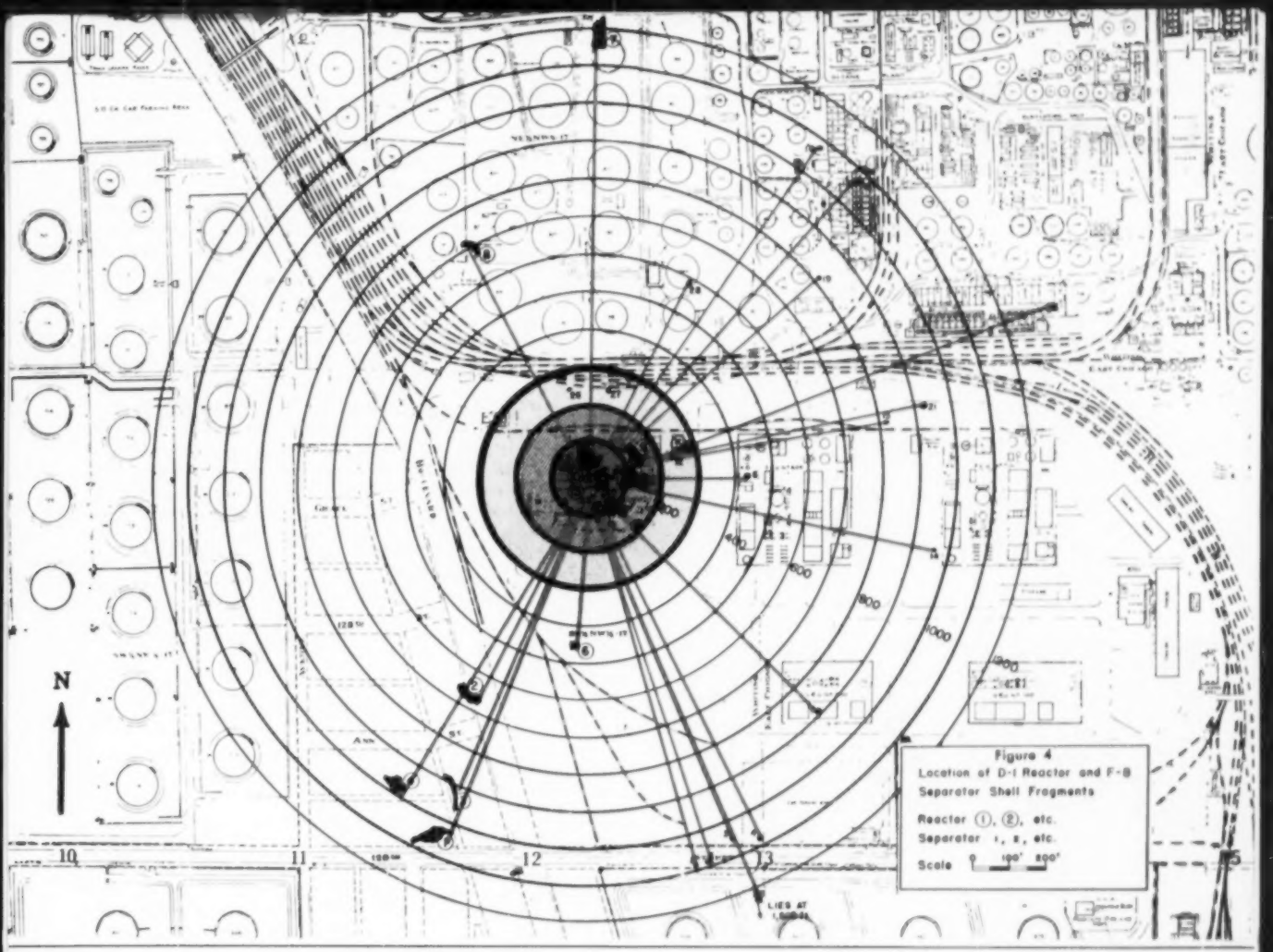


destruction of a large refining unit by

gaseous detonation

R. B. Jacobs, W. L. Bulkley, J. C. Rhodes, and T. L. Speer

Standard Oil Company (Indiana)
Whiting, Indiana

A large Fluid Hydroformer (*3*) at Whiting, Indiana, was seriously damaged by a number of internal explosions at 6:12 A.M. on August 27, 1955. The principal explosions, occurring within the reactor vessel and a high pressure separator, completely destroyed both the vessel and the separator. Other detonations took place in the piping, exchangers, a separator drum, and an absorber tower, but the damage to these was less severe and, save for two pipe elbows, no other ruptures occurred.

The violence of the explosions in the reactor and separator drum was sufficient to cause extensive fracturing. Fragments, particularly those from the reactor, were scattered over a radius of about 1,200 ft. Some pieces fell in two working tank fields immediately north of the Hydroformer. The impact on the tanks caused numerous fires which spread rapidly throughout the tank fields ultimately bringing more than 40 acres within the fire area, and eventually destroying sixty-three tanks and approximately 1,270,000 bbl. of crude and various products (*1*).

Description of Unit

At the time of the explosion, the unit was being started up after a shutdown for mechanical repairs.

At this stage of the start-up, the two major vessels, reactor and regenerator (Figure 1), were being heated simultaneously, the latter with compressed air through the air heater B-5 via the combustion air line, and the former by circulation of inert gas through the combination furnace B-1. The air system was normally held at about 10 lb./sq.in. lower pressure than the inert gas system. Naphtha circulation through the unit (except the reactor, which was by-passed for this operation) was in progress. Through a series of unfortunate circumstances, the recirculating inert gas became contaminated with air and naphtha vapors, forming a flammable mixture estimated to contain about 19% O_2 and 3% naphtha vapor at about 105 lb./sq.in. gauge. No catalyst was present in the system at the time.

The Fluid Hydroformer stood 260 ft. above ground level (Figure 2). The reactor vessel was 127 ft. in total length and 23.5 ft. in diameter. It was fabricated of alloy steel plates varying in thickness from 2⅛ to 2¼ in. Two regenerator exhaust stacks and six relief valve outlets are shown at the top of the unit. The wreckage at the unit site is shown in Figure 3. About 44% of the reactor vessel was hurled beyond the area shown; pieces remaining can be seen in the upper central portion of the photograph.

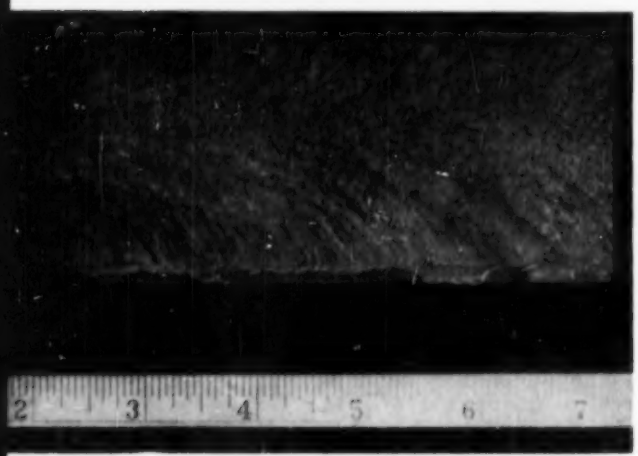


Fig. 5. A section from the shell of the reactor vessel. Note the herringbone or chevron pattern pointing to the left toward the origin of the crack; the pointing of the chevron is opposite to the direction the crack propagates or runs. This fracture exhibits shear lips (about 3/16 in.) at the plate surface.

Eyewitness Accounts

At the time of the explosion, a number of people in the immediate vicinity of the refinery (sufficiently close so that the transit time for sound would be well under 1 sec.) saw luminous flames issue from near the top of the Hydroformer. After several seconds they heard a loud report from that direction, and then they saw the "large" vessel (reactor) disintegrate and the pieces fly through the air. Subsequently, they heard a second more violent report and soon the area was enveloped in smoke and flames.

Most of the operators on the unit were in the vicinity of the control room at the time. Generally, they recalled a rumbling noise, then a first explosion which knocked some of them down; this report was followed by a cloud of smoke and dust which greatly reduced visibility. After they had recovered their footing and had started to run, a second violent detonation occurred, again knocking some of them off their feet. After this there was a number of smaller explosions.

Distribution of Damage by Fragments and Blast Wave

The vessel fragments which were seen to fly through the air were later located in the positions shown in Figure 4. Of particular importance from a damage point of view are those lying to the north of the unit since these are responsible for rapidly initiating the fires which engulfed that tank field. Piece No. 7 (see Figure 4), which weighed about 60 tons, landed on a tank containing gasoline-base stock, smashed it severely, ignited and scattered its contents. When this piece was hurled through the air it had roughly the same speed (and weight) as a DC-7 airplane.

Some Problems for the Investigators

The principal source of evidence for the investigation of this disaster was the large pile of wreckage shown in Figure 3. Some of the instrument records were intact, but others appeared hopelessly lost in the grime and oil where they had fallen. Restoration of these damaged records was reasonably successful and provided highly useful information.

There were two aspects to the investigation:

- The determination of the exact sequence of events which produced the flammable mixture and its subsequent ignition. This part of the story has been outlined in previously published material (*1,4*). Suffice to state here that through accident a flammable mixture was produced in certain parts of the unit, including the reactor vessel. Ignition probably occurred on the heated surfaces of the furnace tubes in the recycle gas circuit.
- Reconstruction of the disaster from the scattered and often fragmentary evidence, a difficult task, especially since the investigation was immediately confronted with a number of apparent contradictions.

The first question was: "How could a mixture of hydrocarbons and air generate sufficient destructive violence to shatter the reactor and hurl it apart?" Calculations of the explosive pressure made by the usual methods would predict, under the conditions then existing, that the reactor should not have failed, and, furthermore, the calculated available energy fell somewhat short of that needed to hurl the fragments by the most efficient probable mechanism.†

A second question was: "How could two almost equally violent explosions occur a number of seconds apart?" There was difficulty visualizing a mechanism whereby the two vessels, reactor and high pressure separator, separated by ¼ mile of piping, could both blow up, one several seconds after the other. One could reason that if ignition occurred in one vessel and it exploded, thus opening the system to the atmosphere, it would be difficult for the flame to travel into another vessel since the latter would be rapidly discharging its contents against the direction of flame travel.

Still another question was: "Did the several eyewitnesses close by the site of the disaster really see a large flame issue from the unit several seconds (Transit time of sound here was less than 1 sec.) before it exploded and, if so, how did this happen?" Also, how could those eyewitnesses about one mile away first hear (Transit time of sound here would be 4 to 5 sec.) a loud report and then see the reactor blow apart?

Only when it was realized that a

† These calculations assumed that the crack-up of the vessel was substantially completed before outward movement of the parts began. The acceleration of the parts was calculated on a stepwise basis on the assumption of adiabatic conditions and the movement of all parts outwards normal to their original orientation. The assumption of normal movement provides for a more efficient process than would occur if the parts rotated, in which case escape of gas would be more rapid and the averaged pressure times area product less.

BEFORE ►

Fig. 2. The Fluid Hydroformer before the explosion.

series of internal detonations had taken place was it possible to fit the various pieces of the story together in a consistent manner.

The following characteristics of detonations appear to have played significant parts in this disaster:

1. predetonation flame travel, especially the effect of vessel size and geometry upon the length of the predetonation period
2. the effect of turbulence in accelerating detonation
3. the high pressure developed in the detonation front
4. the concentration of energy in the detonation front

Nature of Explosion Within Reactor Vessel

Figure 5 shows a typical herringbone pattern that was found along the edges of the different reactor fragments. This pattern yields information concerning: (1) direction in which the cracks propagated, and (2) type of failure (cleavage), and hence the approximate speed of crack propagation (about 5,000 ft./sec.) (*4*).

The long uninterrupted cleavage marks suggest that the detonation velocity was less than 5,000 ft./sec., and once cracking the vessel was initiated, the original cracks propagated extensively. Had the detonation velocity been greater than 5,000 ft./sec., the detonation pressure wave probably would have produced a large number of new cracks ahead of the old ones. The new cracks would have intersected and terminated the earlier fractures, thereby producing greater fragmentation of the vessel.

Figure 6 gives results of a number of calculations relating to the energy of the explosion. Of particular importance is the fact that whereas a detonation does not produce a greater total energy release than does an ordinary explosion, it has the effect of a more efficient propellant because the energy is concentrated in the detonation wave.

For a reconstruction of the reactor vessel and its internal catalyst stripper well, the former shown in developed form, see Figure 7. A number of observations of internal reactor damage and the calculated pressures required to produce this damage are shown. It will be seen that there are numerous proofs of instantaneous local pressures which far exceeded the 800-900 lb./sq.in., the highest pressure that would have been possible without detonation.

Fig. 3. The Fluid Hydroformer after the explosion.

AFTER ►

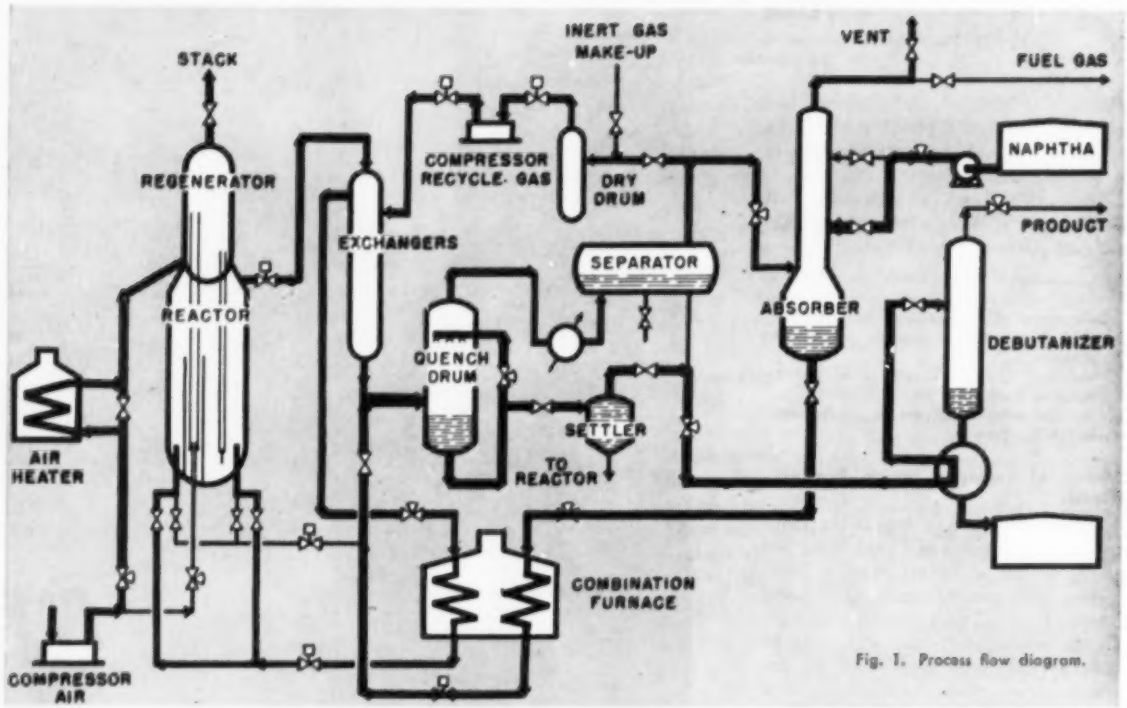


Fig. 1. Process flow diagram.

TRACING THE FLAME PROPAGATION

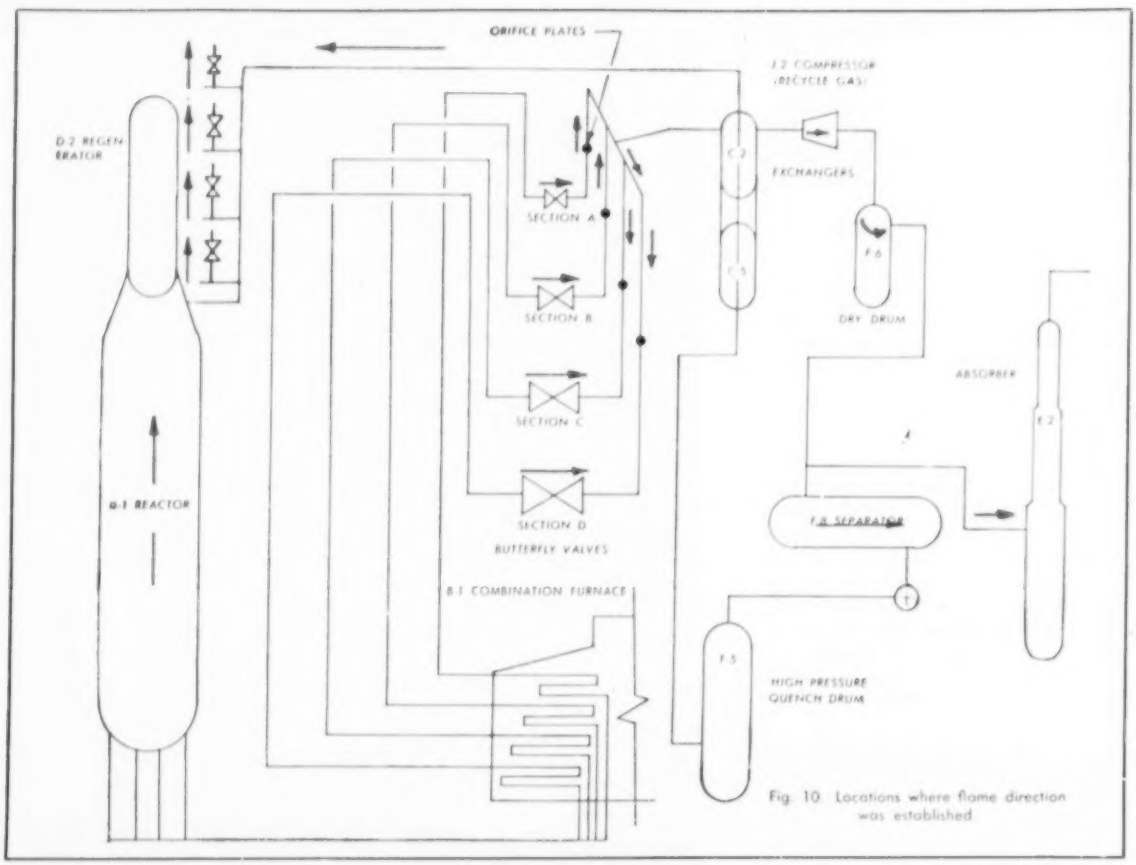


Fig. 10. Locations where flame direction was established

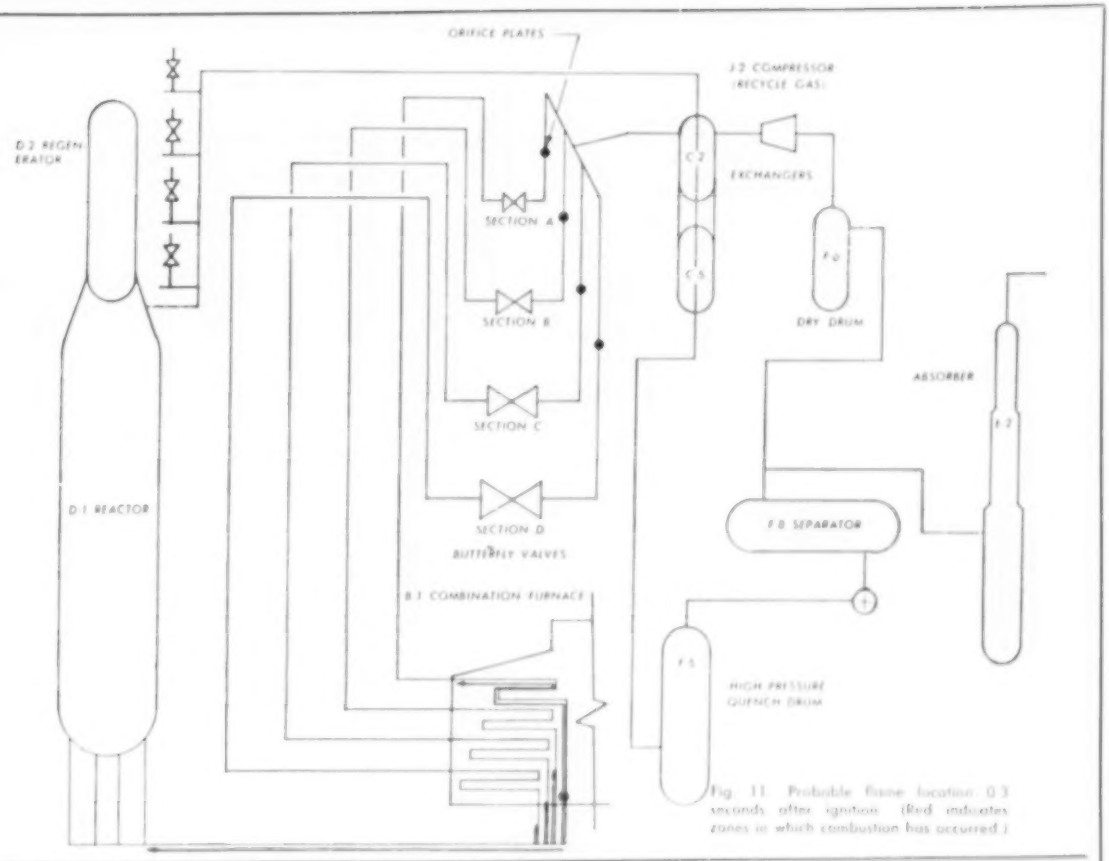


Fig. 11. Probable flame location 0.3 seconds after ignition. (Red indicates zones in which combustion has occurred.)

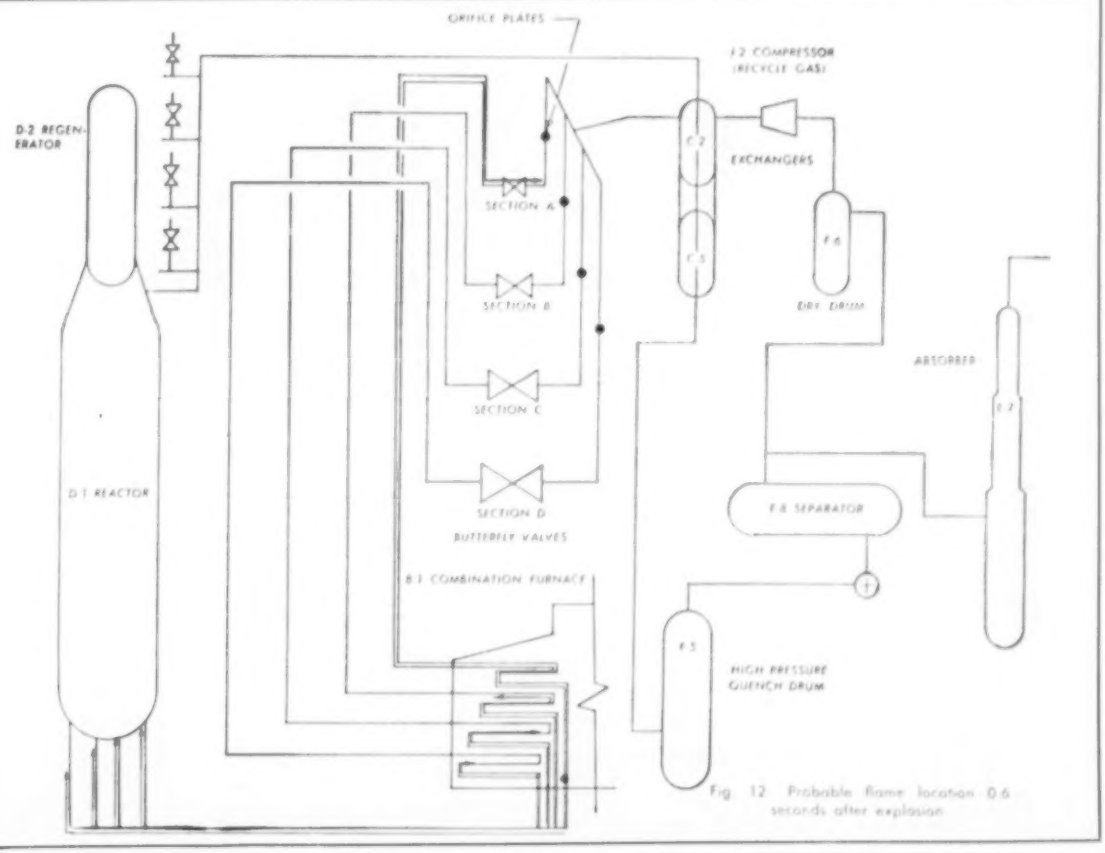


Fig. 12. Probable flame location 0.6 seconds after explosion.

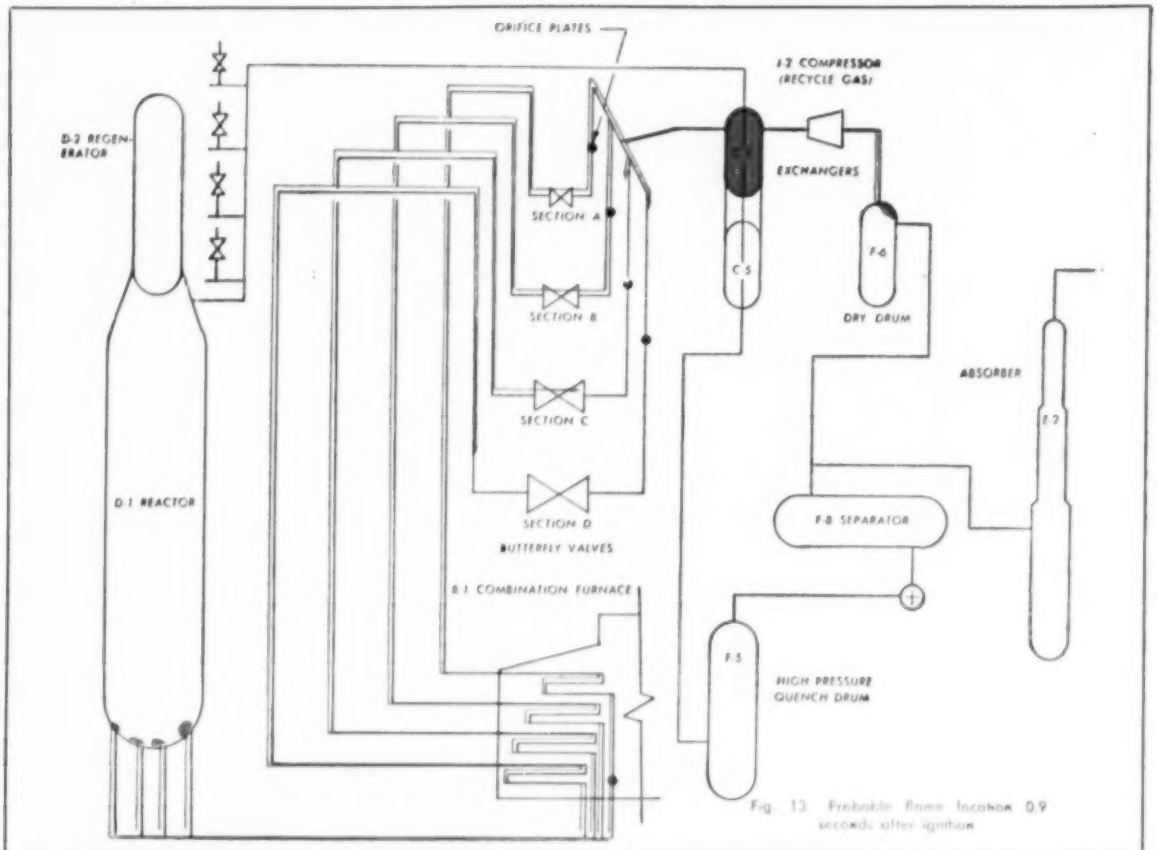


Fig. 13. Probable flame location 0.9 seconds after ignition

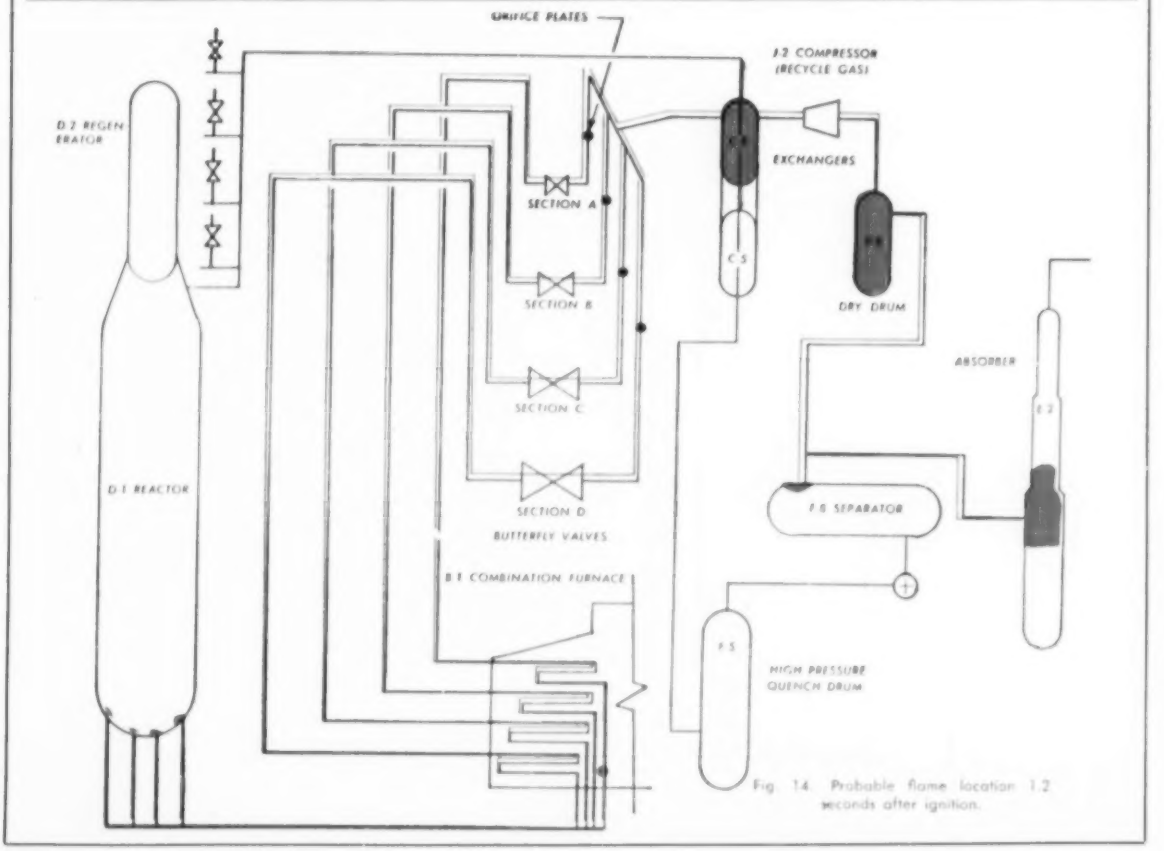


Fig. 14. Probable flame location 1.2 seconds after ignition.

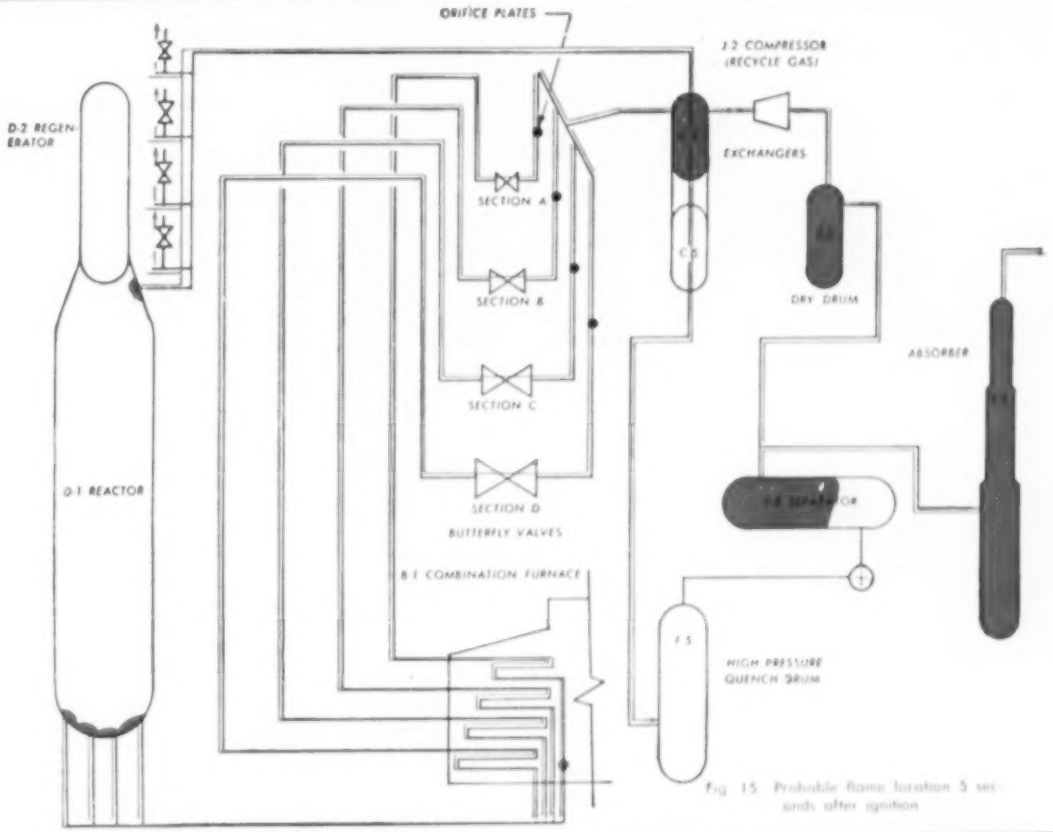


Fig. 15. Probable flame location 5 seconds after ignition.

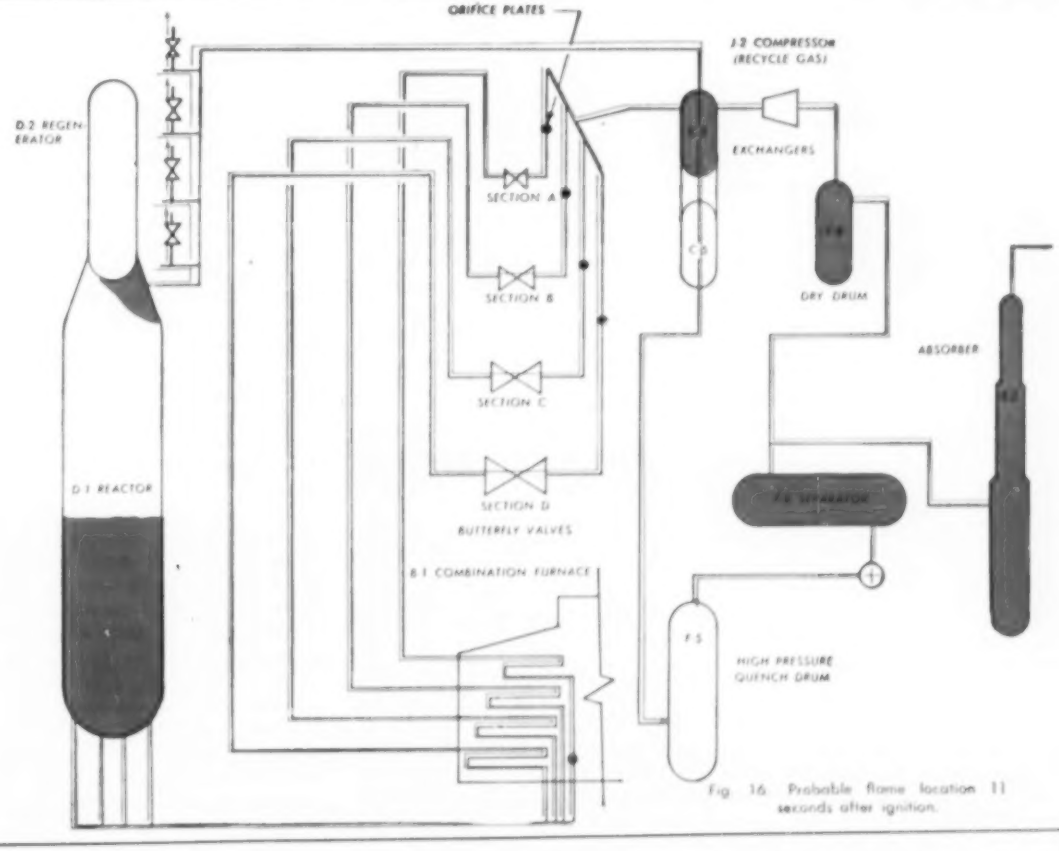


Fig. 16. Probable flame location 11 seconds after ignition.

An interesting story can be told of the catalyst stripper well, the upper half of which is crushed inward at a number of places whereas the lower half is bulged outward at several locations. The damage to the upper half is explained by an upward moving detonation wave in the reactor (external to the stripper) which attained sufficient violence midway up the vessel to produce the observed damage. The bulged portions are explained by a later downward traveling detonation inside the stripper well, presumably ignited by the first detonation as it passed the open ports in the stripper shown about one-third way up this structure.

The reactor fragmentation pattern is shown in greater detail in Figure 8 (see Figure 5 of Randall article, page 579 of this issue). It will be observed that *five* locations of crack origin are found at an elevation three-quarters of the vessel height. This is interpreted to mean that the detonation wave first reached sufficient intensity at this point to shatter the vessel, and it did so in five separate places. After this, cracks propagated upward and downward, and at a lower elevation secondary cracks apparently originated as a consequence of bending stresses. It will be recalled that most of the pieces above the center line were hurled far beyond the battery limits, while the bottom of the vessel shifted slightly through recoil, enfolded, and toppled over.

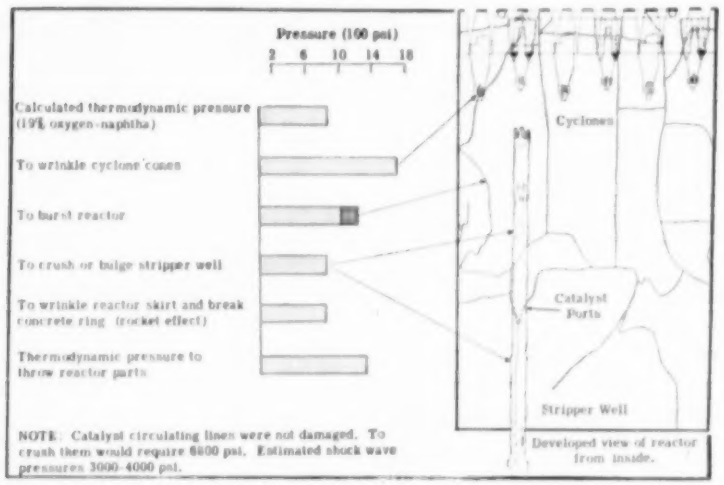

Pressure (100 psi)
2 6 10 14 18
Calculated thermodynamic pressure (19% oxygen–naphtha)
To wrinkle cyclone cones
To burst reactor
To crush or bulge stripper well
To wrinkle reactor skirt and break concrete ring (rocket effect)
Thermodynamic pressure to throw reactor parts
Cyclones
Catalyst Ports
Stripper Well
Developed view of reactor from inside.
NOTE: Catalyst circulating lines were not damaged. To crush them would require 6800 psi. Estimated shock wave pressures 3000–4000 psi.

Fig. 7. Pressure calculations for reactor components.

Progress of Explosion Within the Unit

Careful examination of the wreckage from the unit gave many clues as to the direction of flame travel in the different pipe runs. A useful clue was the Lüders lines (2) (Figure 9). Such lines, produced when the metal is stressed beyond its elastic limit, are particularly noticeable after rusting has taken place on the freshly exposed metal surfaces. Another form of evidence came from internals such as baffles, butterfly valves, and orifice plates. Some of these were dislodged and even blown through near-by elbows. The direction in which they moved served to establish local directions of flame travel. From such information, flame directions were established in the locations shown in Figure 10. Particular attention should be given to the fact that in furnace lines (A) and (B) the flame travel was in one direction only, whereas in lines (C) and (D) the flame travel was in both directions, meeting at an intermediate point. Also one should observe that in the overhead reactor line to the C-2 exchanger the direction of flame travel was *toward* the reactor and that it reached the atmosphere through the pressure relief valves.

Figure 10 shows the same part of the unit as does Figure 1, with the difference that the circuit through the recycle furnace is now shown in four parallel passes as it actually existed. There was a marked decrease in extent of damage to the different lines from (A) to (D), all four of which showed evidence of internal explosion. The explanation here is that (A) blew first, partially relieving the pressure on the others; (B) blew next, further reducing the pressure, etc. The fact that in (C) and (D) butterflies were blown in one direction and orifices in the other proved† that these lines contained two simultaneous explosions traveling in opposite directions.

In the next series of figures, an attempt is made to re-create the progress of the explosion within the unit, consistent with the accounts by eyewitnesses and with observed damage. Here it is postulated that detonation fronts travel at about 3,000-4,000 ft./sec., which is probable for a 19% O_2, 3% C_5 hydrocarbon mixture. It is assumed that predetonation times in the highly turbulent (60-100 ft./sec.) recycle lines are short (of the order of a few thousandths of a second) but are much longer in the relatively quiescent vessels, depending upon the size of these vessels. Ignition is assumed to have occurred in a hot recycle furnace tube, specifically in Section A (explained later).

In Figure 11 the situation is shown as it possibly existed 0.3 sec. after ignition. Two detonation waves traveling in opposite directions are shown in Section (A). The one traveling downstream toward the reactor has ignited, the other three furnace lines and flames are now progressing upstream in these lines toward the C-2 exchanger. At 0.6 sec. after ignition, flames have progressed to the points shown in Figure 12 and have ignited the reactor.

At 0.9 sec. after ignition (Figure 13), the detonation in Section (A) has traversed the entire section, blowing the butterfly disk, shown in the horizontal pipe run, to the right and blowing the orifice plate in the vertical run beyond in the upward direction. The detonation wave in Section (B) proceeded next, and was similar to that in (A), except for a lessened intensity due presumably to a reduced local pressure as a result of an opening to the atmosphere in Section (A). Sections (C) and (D) are now ignited at both ends and have oppositely directed flame fronts advancing toward their centers. These secondary flame fronts were ignited by the (A) front as it reached the common header. The flame front also has reached the shell side of exchanger C-2 and has ignited F-6.

At 1.2 sec. after ignition (Figure 14), Sections (C) and (D) have exploded, the valve disks here being driven to the right and the orifice plates downward by the two oppositely directed flame fronts. A detonation has developed in the C-2 exchanger, rupturing a number of tubes here and allowing the flame to jump from the shell side to the tube side in this exchanger. This, it will be noted, is the only possible means of ignition which would develop a flame front traveling

† Lüders lines had actually predicted the correct picture of flame travel here before internal inspection revealed the direction in which the orifice plates had traveled.

toward the reactor in the overhead vapor line since a flame could not come from the direction of the high pressure quench drum because the contents of this drum were too rich to burn. Although the external examination clearly predicted this mode of flame travel, a formidable obstacle to this hypothesis was nevertheless present: namely, a detonation of sufficient violence to rupture the tubes would easily have disintegrated the condenser shell. Yet the shell was only bulged. This suggested that perhaps the tubes had not been ruptured, but that they had been heated sufficiently to serve as a source of ignition. This also was difficult to explain due to the short residence time of the detonation in the exchanger. When the exchanger shell was finally cut open for inspection, it was revealed that a number of tubes had been sheared by the action of a baffle plate which was dislodged by the explosion.

Five seconds after ignition (Figure 15), flames were issuing from the relief valves on the top of the unit. (This explains the observation of several people in the near vicinity who saw these flames before they heard the explosion.) The flame front which entered the shell side of the C-2 exchanger has passed through the centrifugal recycle compressor, blowing the blading in its direction of travel, and has advanced to the F-8 separator, where a well-developed flame front has been established. This detonation exerted great force upon impact with the vessel head shown to the right, shattering the vessel and hurling the pieces generally to the right and upwards. The explosion of this vessel is believed to have preceded that of the reactor for several reasons. First the location of the pieces of wreckage, although not conclusive, points in this direction. Second the vessels are believed to have exploded about 4 sec. apart, and had the reactor exploded first, the F-8 separator would have lost too much pressure in the intervening 4 sec. to have exploded in the indicated manner. The pressure loss in the reactor as a result of the rupture of F-8 would be considerably less due to its much greater volume.†

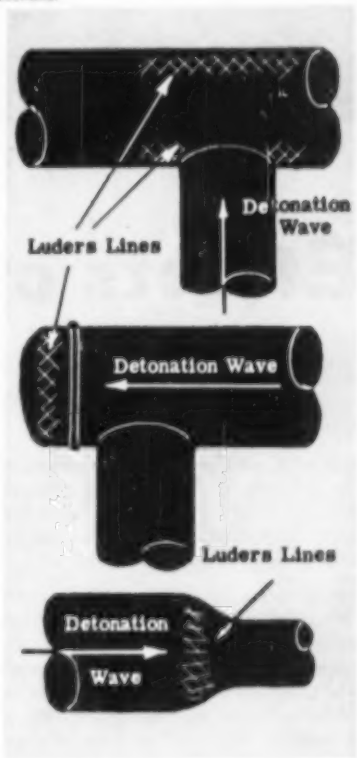
At about 11 sec. after ignition (Figure 16) the flame front in the reactor had developed sufficient intensity to have ruptured that vessel, hurling the pieces of the upper half through the air in the manner previously described.

This late rupture of the reactor vessel agrees with the account of witnesses located about 1 mile away who first heard an explosion and upon looking up saw the reactor unfold and fly apart. Undoubtedly, their attention was attracted by the detonation of the F-8 separator since they would not have heard the reactor explosion until 4 or 5 sec. after it disintegrated.

The reader will observe that this sequence of events, deduced from physical evidence, is in agreement with the known properties of detonations and resolves the apparent conflict of eye-witness accounts.

▲ **Fig. 9a. Specimen containing Lüders lines taken from knuckle section of high pressure separator F-8.**

▼ **Fig. 9b. Lüders lines formed by shock waves encountering sharp elbows or reduced sections.**

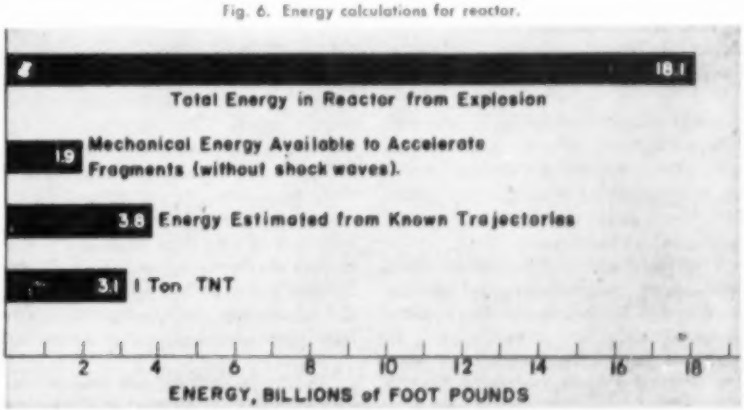


Literature Cited

1. Anon., *Petroleum Processing* **11**, 39 (January, 1956).
2. Carpenter, H., and J. M. Robertson, "Metals," Vol. I, p. 130-33, Oxford University Press (1944).
3. Christopher, Robert G., *Petroleum Refiner* **34**, 165 (September, 1955).
4. Ducommun, J. C., "6:12 at FHU-700," presented to 36th annual meeting Am. Petroleum Inst. (November 14, 1956).
5. Saibel, Edward, "Fracturing of Metals," p. 275-81, *Am. Soc. Metals*, Cleveland, Ohio (1947).

Presented at A.I.Ch.E. meeting, Chicago, Illinois.

Fig. 6. Energy calculations for reactor.



† **Calculations based on leakage through the lines known to have been severed by the reactor and high pressure separator respectively predict that the separator pressure would have been reduced to one-half its original value in slightly more than 2 sec., while about 20 sec. would be required for the reactor pressure to be similarly reduced.**

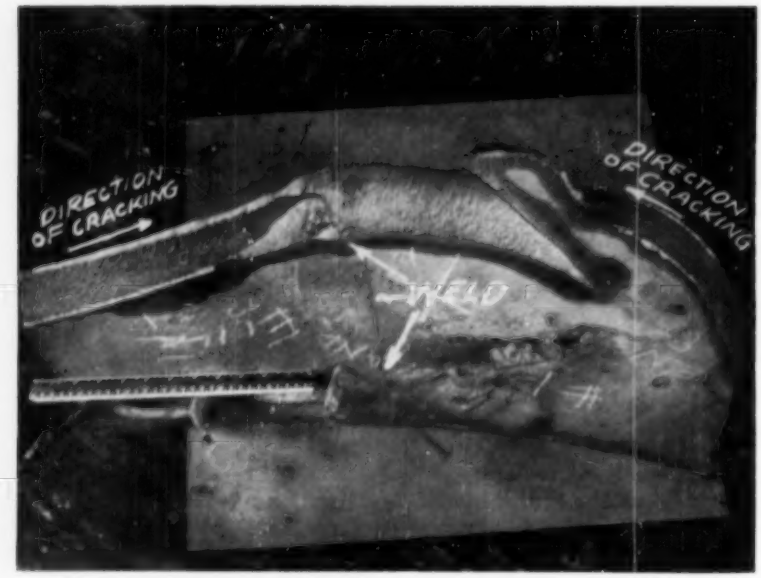


Fig. 6. Section of reactor shell, part of piece 2 at south weld line, at 5th to 6th course girth weld (see Figure 5). The fast running cleavage fracture at left was slowed down at the girth weld and changed to a full shear fracture before it stopped. A second cleavage fracture at the right has been intersected by the shear crack, completing the rupture of the shell fragment (piece 2 of Figure 5).

Effects of gaseous detonations

P. N. Randall, J. Bland, W. M. Dudley, and R. B. Jacobs[a]

This article represents work done in investigating the explosion which destroyed the refinery at Whiting, Ind. (described by Jacobs, et al., in the preceding article). Parts I and II consider the principles involved in the rupturing of pipes and vessels by gaseous detonation; part III gives pertinent engineering and metallurgical information and discusses their relevance to the explosion.

This discussion (Part I) deals with the reaction of a pipe wall to a detonation. For simplicity the pressure pulse has been considered a square wave, having zero rise time from an initial pressure of one atmosphere to a constant "plateau" of peak pressure and finally a sharp decrease in pressure. This assumed pressure-time relationship produces simple harmonic motion of the pipe wall, as long as the strain is entirely elastic. However, no fundamental difficulties are introduced by the use of a more realistic pressure-time relationship if desired. The assumption of zero rise time is quite accurate, for it will be shown that the natural period of ordinary pipe and vessels is long relative to the actual rise time of the pulse.

This fact leads to an important effect on the hoop or circumferential stresses produced in the pipe wall. In the present case these stresses are not simply related to the pressure, as they are in the static case, but must be obtained from the circumferential strains in the pipe wall. The strains in turn are governed by the motion of the pipe wall and therefore are a function of time as well as of pressure. Stated another way, the stress is highly dependent upon the inertia of the pipe wall.

One effect of the rapid loading produced by a detonation wave is a doubling † of the resulting stresses in certain cases. This occurs when (1) the strains produced are entirely elastic, and (2) the duration of the pulse is more than one-half the natural period of the pipe wall. It occurs because the outward moving pipe wall has a considerable velocity when it first reaches the position that it would attain under the same pressure applied statically. The subsequent deceleration of the wall produces additional strain. Another interesting case is that in which the pipe wall yields plastically. Here the amount of strain is limited by the duration of the pressure pulse if the latter is of short duration. Hence, if the pipe retains ductility under the shock loading, it may be able to "ride with the punch" and resist high pressure pulses of short duration without fracture. It is shown also that because of the inertia of the pipe wall, the build-up of stress at a point in the pipe is not instantaneous, as is the shock wave pressure build-up at that point. These effects are analyzed in the following sections.

For the sake of simplicity, the effects of strain rate on the stress-strain characteristics and on the ductility of the pipe material have not been considered in this study. When the material is referred to as being "brittle" or "ductile" the term refers to the behavior of the material under the particular conditions described. Also, the pipe is considered to be thin walled having a large ratio of diameter to wall thickness. Thus the state of strain is considered to be the same at the outer surface of the pipe as it is at the inner surface at any instant.

[a] Messrs. Randall, Bland, Dudley, and Jacobs are associated with the Engineering Research Department.

† Not to be confused with pressure multiplication induced by reflection of shock waves.

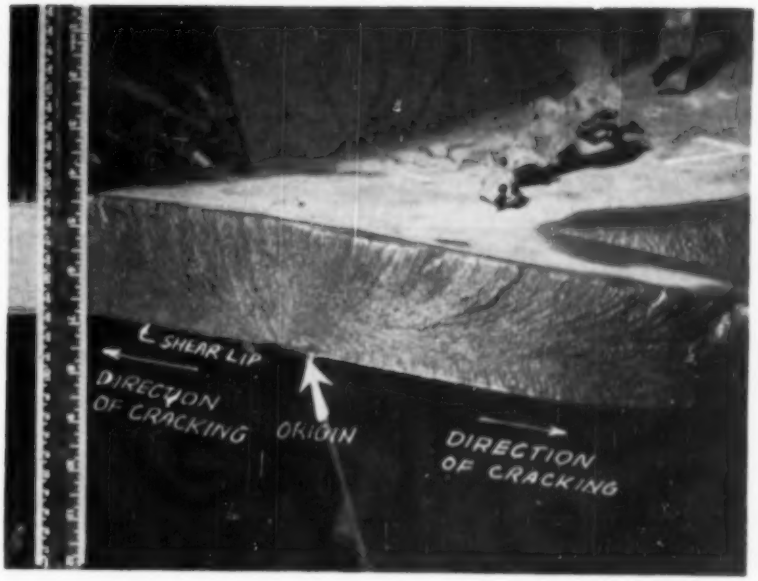


Fig. 7. Right-end view of section shown in Figure 6. This shows the typical herringbone or chevron pattern pointing back toward the origin of the crack indicated by arrow, which was an arc strike on the outside surface of the reactor shell. Note the crystalline appearance of the cleavage fracture and the narrow shear lips at the surfaces of the plate. Approx. X-½.

upon vessels and piping

Standard Oil Company (Indiana), Whiting, Indiana

Elastic Motion of Pipe Wall

The general equation of motion is that of a mass, the mass of a unit area of the pipe wall, acted upon by a suddenly applied force, P, the pressure pulse, and by a restraining spring force, which is the radial component of the hoop stress in a unit length of the pipe wall. These are illustrated in Figure 1.

The pipe wall is a spring of stiffness K determined as follows: The radial motion caused by the pressure, P, (static) is:

$$r = \frac{PR_0^2}{Eh}$$

$$K = \frac{P}{r} = \frac{Eh}{R_0^2}$$

The natural period of a simple spring and mass system of this type is:

$$T = 2\pi\sqrt{\frac{m}{K}}$$

or for the pipe,

$$T = 2\pi R_0\sqrt{\frac{\rho}{gE}}$$

Within the elastic region, the motion of the pipe wall will be governed by the following general equation:

$$\frac{d^2r}{dt^2} = \frac{P}{m} - \frac{Kr}{m} \qquad (1)$$

which states that the radial acceleration of a unit area of the pipe wall is directly proportional to the net force on the wall and inversely proportional to its mass.

The solution of this equation, in terms of the time elapsed after the application of the pressure pulse, describes the harmonic motion of the pipe wall.

The radial motion is

$$r = \frac{PR_0^2}{Eh}\left(1 - \cos\frac{t}{R_0}\sqrt{\frac{gE}{\rho}}\right) \qquad (2)$$

The radial velocity is

$$\frac{dr}{dt} = \frac{PR_0}{Eh}\sqrt{\frac{gE}{\rho}}\sin\left(\frac{t}{R_0}\sqrt{\frac{gE}{\rho}}\right) \qquad (3)$$

And the radial acceleration is

$$\frac{d^2r}{dt^2} = \frac{Pg}{\rho h}\cos\left(\frac{t}{R_0}\sqrt{\frac{gE}{\rho}}\right) \qquad (4)$$

Elastic Plus Plastic Motion of Pipe Wall

For cases in which the radial motion exceeds that which can be accommodated elastically, the above equations apply until yielding begins. By their use, the time required to reach the yield point, and the velocity and acceleration of the pipe wall at that instant can be computed.

At the end of the elastic action, it is assumed the material becomes perfectly plastic as shown in Figure 2. The assumed condition is fairly well met by low carbon steel which commonly has a yield point elongation of 1 to 5%. If conditions are conducive to brittleness, cleavage fracture will occur at some strain in the plastic region.

When the yield point is reached, the resistance of the pipe wall to further motion becomes constant. Hence, the acceleration remains constant until the end of the pressure pulse is reached, or, if the acceleration is negative, until the pipe wall comes to rest. The velocity at the end of the pressure pulse, or the time for the pipe wall to come to rest is readily computed, as well as the radial motion involved. These steps are best described in connection with the following illustration.

Examples:

Four cases have been chosen to illustrate the effect of the magnitude of the pressure pulse on the motion of the pipe wall. The four pressures were:

Case (1) P = 2,150 lb./sq. in. gauge = 0.5 times the static yield pressure

Case (2) P = 2,500 lb./sq. in. gauge = 0.58 times the static yield pressure

Case (3) P = 4,300 lb./sq. in. gauge = 1.0 times the static yield pressure

Case (4) P = 8,600 lb./sq. in. gauge = 2.0 times the static yield pressure

A 2-in. standard weight pipe was chosen for all four cases and a square-wave pressure pulse of 25-microsec. duration was used throughout. Other values were:

Yield point stress = 30,000 lb./sq. in.

$E = 30 \times 10^6$ lb./sq. in.

P_o = 4,300 lb.sq.in. gauge computed from the assumed yield stress and the pipe dimensions

Case (1). P = 2,150 lb./sq.in.gauge = 0.5 times the static yield pressure, represents the maximum pressure which can be applied rapidly without exceeding the yield point of the material. It is illustrated in Figure 3, in which the acceleration, the velocity, and the radial motion of the pipe wall are plotted against time. At time zero, the pipe wall is at rest; the velocity is zero; the radial strain is zero; and the acceleration is that imposed by the pressure pulse. A few microseconds later, the pipe wall has moved outward, developing some hoop stress which provides elastic resistance to the motion, the elastic resistance being additive to the inertial resistance of the pipe wall. After 8.2 microsec. elapsed time, one-fourth the natural period, the velocity of the pipe wall reaches a maximum of 101 in./sec. After 16.4 microsec., one-half the natural period, the outward motion is halted at a value of 0.00105 in., corresponding to 0.1% strain and a stress just equal to the yield point. The pipe wall then moves inward, and if the pressure pulse were maintained, it would oscillate between the positions $r = 0$ and $r = 0.00105$ in. until it was damped out, finally coming to rest at $r = 0.00052$ in. and a stress of one-half the yield point. If the pressure pulse ended suddenly after 25 microsec., a new oscillatory motion would be established as shown in Figure 3, which would finally damp out and the pipe wall would come to rest at $r = 0$. In actual practice the pulse does not end suddenly. Also, the oscillatory motion would not normally damage the pipe. Consequently, in the following cases, the motion of the pipe wall is described only up to the time the pipe wall is first brought to rest.

Case (2). P = 2,500 lb./sq.in. gauge, = 0.58 times the static yield pressure, is also illustrated in Figure 3. The initial acceleration is higher because the pressure is higher. As in the previous case, the maximum velocity is achieved at the end of 8.2 microsec., one-fourth the natural period, but the velocity achieved is greater. After 12.3 microsec., the strain, and hence the stress reaches yield point magnitude. This occurs in a period of deceleration, the magnitude of which remains constant, resulting in a linear decrease in velocity to zero at time, $t = 17.3$ microsec. The maximum radial motion is 0.00120 in.

Case (3). P = 4,300 lb./sq.in. gauge, = 1.0 times the static yield point, is shown in Figure 4, which is plotted to smaller scales than Figure 3 because all values are much larger than in Cases 1 and 2. This is a rather special case. The acceleration becomes zero and the velocity a maximum at 8.2 microsec., one-fourth the natural period. The travel at this instant is just sufficient to attain the yield point; therefore there is no decelerating force and the velocity stays constant at 200 in./sec. until the end of the pulse. The radius therefore increases linearly from time 8.2 to time 25.0 microsec. After the pulse ends, the pipe wall is decelerated by a stress in the pipe of yield point magnitude and continues to move outward at a continually decreasing rate. As shown in Figure 4, the velocity becomes zero at 30.2 microsec., the maximum radial motion being 0.005 in.

Case (4). P = 8,600 lb./sq.in. gauge, 2.0 times the static yield pressure, is also illustrated in Figure 4. Yield point strain is reached after only 5.4 microsec. in this case and the pipe wall acceleration then becomes constant until the end of the pressure pulse. The velocity therefore increases linearly from $t = 5.4$ to $t = 25$ microsec., reaching a maximum value of 1,120 in./sec. The radial strain at this instant is about 1.5%, hence, it is very possible that fracture would take place and the velocity of the pipe wall would

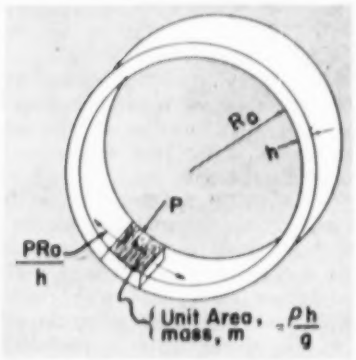


Fig. 1. Definition sketch of pipe element.

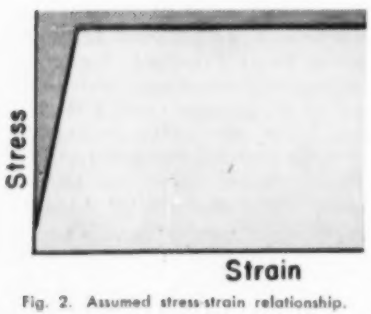


Fig. 2. Assumed stress-strain relationship.

PART II. CALCULATION OF VELOCITIES OF FRAGMENTS

Introduction

When a vessel is shattered into a fairly large number of fragments by an internal explosion, with or without detonation, the mechanics of accelerating the pieces and expanding the products of combustion are simple enough so that an average velocity for the fragments can be computed. Some hypothetical cases relating to two actual explosions have been studied in this way. In these cases, the composition of the exploding mixtures could be established within certain limits from the operating records. The possible range of fragment velocities could be computed from trajectory equations, knowing the starting and end points. The results of the acceleration calculations were consistent with the other known data, indicating that such calculations could be used as a means of establishing roughly the initial presure of an explosion and, hence the characteristics of the exploding mixture. Also, it was found that the efficiency of transferring mechanical energy to the fragments varied only within a narrow range. With an average value for this efficiency, fragment velocities can be computed readily for any explosion without resorting to further tedious step-by-step arithmetic.

In large vessels, the mechanics of the gaseous detonation process are only partially known at present, and the amount of energy required to fragment a vessel under shock conditions is also somewhat conjectural. Calculations of fragment velocities based upon

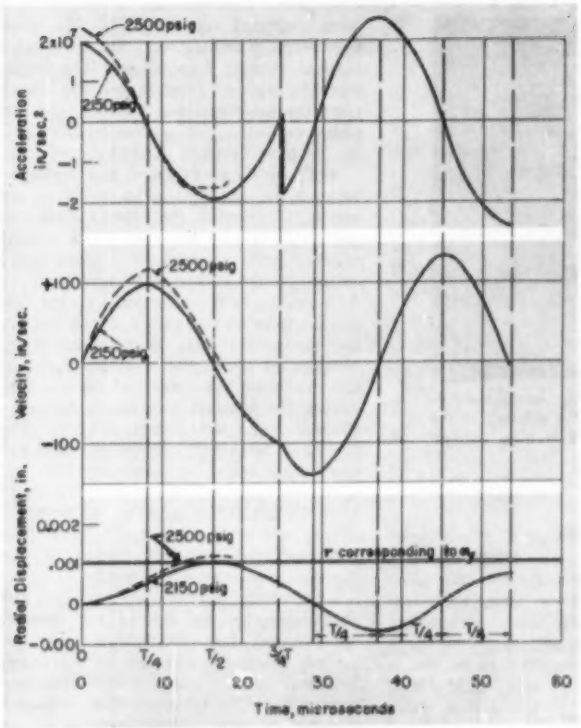


Fig. 3. Motion of the pipe wall, cases 1 and 2.

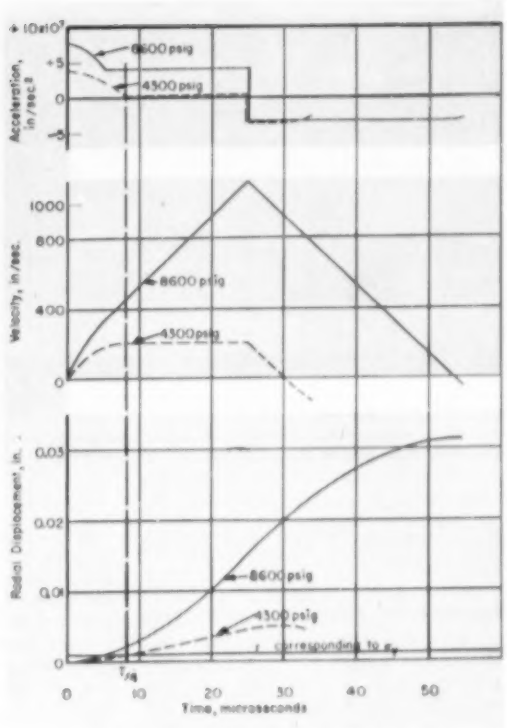


Fig. 4. Motion of the pipe wall, cases 3 and 4.

add materially to the final missile velocity computed as described below. If no fracture occurs, the motion of the pipe wall is finally halted after a total time of 54 microsec. and with a maximum radial motion of 0.031 in.

Comments

Case 1 illustrates the familiar doubling effect of a rapid application of the load, compared to a gradual one. This applies only to elastic behavior. Case 4 illustrates the importance of the duration of the pulse and of ductility in controlling the damage done by a detonation in a pipe. Cases 3 and 4 illustrate the fact that pressure at or above the static yield pressure will not only produce large strains, but also large strain rates. The latter are computed by dividing the velocity of the pipe wall by the radius. It has been assumed in these calculations that the yield point of the material is unaffected by the strain rate, but in some low carbon steels the effect may be very large and in most materials it is appreciable. It will be noted that a material in a brittle condition could fracture under conditions of Case (1) (P = 2,150 lb./sq.in.gauge), whereas the same material in a ductile condition could conceivably withstand the much more severe conditions of Case (4) (P = 8,600 lb./sq.in.gauge).

available shock tube data indicate that, if the peak pressure in the shock wave is not more than three or four times the simple constant-volume combustion pressure, and if the duration in a large vessel is also similar to that in a shock tube, these higher pressures are applied at any one point for such a short time that their contribution to the total velocity of each fragment is of the order of 10%. This is based on the assumption that none of the extra energy is used in crack-forming, so that all of it is available for accelerating fragments. The effect of a detonation wave on fragment velocity increases more rapidly than the peak pressure, since the duration of the wave is likewise increasing. The effect will also be greater if the wave strikes the surface normally instead

Table 1.—Computed Fragment Velocities

Vessel	Initial pressure lb./sq. in. abs.	Initial temperature ° F.	Adiabatic exponent k	Fragment velocity ft./sec.	Efficiency %
A	788	4106	1.4	370	27.0
A	553	2582	1.4	305	27.7
B	6393	5382	1.287	327	18.0
B	5639	4092	1.317	302	18.8
B	5256	4112	1.314	292	18.8
B	4588	2851	1.349	269	19.8
B	3844	2737	1.347	246	20.0
B	3150	1972	1.361	219	20.2
B	2697	1571	1.377	200	20.5
B	2183	1307	1.383	178	20.6
B	1551	994	1.390	141	19.1
B	998	500	1.398	110	19.2
B	575	392	1.422	75	17.3
B	315	30	1.4	61	22.6
B	215	30	1.4	46	20.5
B	115	30	1.4	28	17.1

Fig. 8. A section from the shell of the high pressure separator. Note the herringbone or chevron pattern pointing to the right toward the origin of the crack; the pointing of the chevron is opposite the direction the crack propagates or runs. This fracture exhibits almost no shear lips at the plate surface. Approx. X-¾.

of running parallel to it as it does in a shock tube.

Procedure for Acceleration Calculations

The acceleration calculation was carried out as follows:

- A section of a cylindrical vessel between two planes perpendicular to the axis was considered. The initial pressure and temperature were known or assumed from the results of combustion calculations. The total weight of gas in the section was computed by the gas law, and the adiabatic exponent k was found from the composition of the gaseous products of combustion; k ranged from 1.28 to 1.42. (Calculations have shown that fragment velocities will increase as k is decreased.) The vessel was assumed to be fragmented by a detonation wave, so that at the instant of beginning the acceleration calculation, the vessel consisted of separate pieces, still in their original positions, with the inside space filled with gas at the thermodynamic temperature and pressure computed for the gas mixture in question. This approximation neglects any effect of detonation in accelerating the pieces. The effect of detonation upon the acceleration has been estimated as follows:

Shock tube data from Standard's laboratory and elsewhere (*1*) show that, as a detonation wave passes, the peak pressure commonly drops to the simple combustion pressure in some fraction of a millisecond.

For a particular mixture, suppose that the peak pressure is four times the simple combustion pressure, decaying parabolically in half a millisecond. If this pressure acts on a loose fragment, the velocity built up at the end of the first 0.0005 sec. will be twice as great as it would be if the simple combustion pressure had acted during this time. The total time of acceleration for the cases shown in Table 1 (p. 577) ranged from 0.010 to 0.040 sec. Examination of the detailed results shows that if an increment equal to the velocity at 0.0005 sec. in each case is added to the final velocity, the change varies from 3% at low pressures to 15% at high pressures, or an average of about 10%.

- It was assumed that all pieces move outward radially; since both the mass and the accelerating force for each piece are proportional to the area, all pieces will tend to have the same acceleration, and the pieces will tend to remain in a cylindrical pattern as they move out.
- The calculations were made on a step-by-step basis. Successive time intervals of 0.002 sec. were used in hand calculations. Later, some calculations were repeated on the IBM 705 with time steps of 0.0004 sec.; the differences in final velocity were slight. The initial rate of fragment acceleration was found from the mass and the pressure, and the radial velocity and radius at the end of the interval were computed.
- To find the pressure and temperature of the gas remaining inside at the end of an interval, the rate of escape of gas at the end was computed. Axial cracks were treated as sharp-edged orifices with a discharge coefficient of 0.75 and an area proportional to the difference between the radius at the instant, and the initial radius. With the use of the average of the initial and final rates of gas discharge, the amount of gas escaping during the interval was found and subtracted from the initial charge. The pressure and temperature at the end were then found by assuming that the remaining gas had expanded adiabatically from its initial condition to its condition at the end of the interval. Axial flow was neglected, also any escape of gas through circumferential cracks.
- After the approximate pressure and acceleration at the end of the interval were found, the calculations were repeated, using the average of the initial and final rates of acceleration. This procedure is more accurate than one-shot calculations by the employment of a time interval half as long. The length of the

PART III. MECHANICAL AND METALLURGICAL

Parts I and II of this article have considered the principles involved in the rupturing of pipes and vessels by gaseous detonation. This section gives pertinent engineering and metallurgical information and discusses its relevance to the fluid Hydroformer explosion described in the immediately preceding article.

Code allowable stresses were used for all vessels involved; these stresses determined the shell thickness, excluding corrosion allowance as modified by the joint efficiency factor; working pressures and temperatures were well below design values. In the reactor and regenerator vessels, in particular, the internal linings kept the working metal temperature well below the design value.

Calculated bursting pressures for the reactor and high pressure separator, based on actual tensile properties of the shell plates, were 1,170 lb./sq.in. gauge in both cases. The calculated pressures are regarded as good estimates of the hydrostatic bursting pressure, and the effects of the dynamic pressure pulse have not been considered in these calculations. In this connection it is interesting to note that the operating pressure of 105 lb./sq.in. gauge in the reactor just prior to the explosion would have imposed unit stresses in the shell which were less than 9% of the ultimate strength of specimens of steel plate taken from the vessel shell.

A diagrammatic sketch (not to scale) of the rupture and fragmentation pattern of the reactor is shown in Figure 5. Numerous crack origins were observed and cracking appeared to propagate in several different regions simultaneously. It is interesting to note that the lower half of the vessel broke into only two pieces, the crack starting on the west side traveling downward and across the bottom head and then coming up the east side of the vessel, stopping, as a tear, at a girth weld. From the general appearance of the fracture pattern in the reactor, the original zone of the initiation is believed to be the eighth course (from the bottom). Four vertical cracks initiated there, presumably from the effects of a high energy internal shock wave, and ran both up and down. These four "petals" then tended to bend outward, initiating girth cracks at several levels, probably depending on local conditions or upon the presence of chance initiation points such as arc strikes, small defects, etc. Since nearly all the cracks were of a high velocity cleavage type it seems likely that fragmentation was largely complete before any pressure relaxation occurred. Any metal "bridges"

time interval for the calculations is selected so that a second repetition does not change the pressure and acceleration at the end of the interval appreciably from the values found after the first repetition.

• The above procedure was continued through successive intervals until the pressure inside was down to 27 lb./sq.in.abs. At lower pressures, it would be necessary to change the equation for gas flow through the cracks since the outside (back) pressure of 1 atm. would then be higher than critical. However, by this time the rate of fragment acceleration was so small that further changes were neglected in view of the various uncertainties inherent in the calculation; the velocity at this time was reported as the final fragment velocity. The total time of acceleration on this basis usually ranged from 0.010 to 0.040 sec.

Efficiency of the Fragment Acceleration Process

If a volume of gas V_1 at pressure P_1 is expanded adiabatically to volume V_2 and pressure P_2 then:

$$P_1V_1^k = P_2V_2^k$$

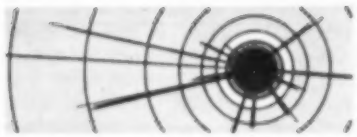
If the expansion is carried out in a machine whose mechanical efficiency is 100%, the amount of work available is:

$$W = \frac{P_1V_1 - P_2V_2}{k-1}$$

For the exploding vessel, P_1 and V_1 are the initial pressure and volume of gas in the section considered. P_2 is atmospheric pressure (taken as 14.7 lb./sq.in.), and V_2 is found from the first equation. W then represents the total available mechanical energy of the explosion. (Although the temperature at condition 2 is usually several hundred degrees above ambient, there is no way to convert this heat to kinetic energy of the fragments.) Since the total mass and the velocity of the fragments are known, their kinetic energy is $E_k = \frac{1}{2}mv^2$; the ratio E_k/W is the efficiency of the acceleration process.

RESULTS OF FRAGMENT ACCELERATION CALCULATIONS

Table 1 shows results of fragment acceleration calculations for several cases. Vessel *A* had an I.D. of 22.5 ft.; the estimated weight of shell plate and lining was 139 lb./sq.ft. Vessel *B* was made of steel, unlined, with 51-in. I.D. and 6-in. wall thickness.



Some further calculations not shown in the table were made to study the effect of k and the orifice coefficient on efficiency. It was found that, other things being equal, a reduction of 0.1 in the value of k raised the efficiency 2.5 percentage points, while an increase of 0.1 in orifice coefficient reduced the efficiency about 1¼ percentage points, and vice versa.

It is obvious that efficiency is affected by several factors, but the following general trends seem to exist: (1) as weight or wall thickness increases relative to diameter, the efficiency is reduced; (2) for a particular vessel, the efficiency is optimum for a certain range of pressures, with somewhat reduced efficiency at higher or lower pressure. None of the above factors produces large changes; for estimating purposes, an efficiency range of 18 to 28% can be used.

which then remained unfractured were torn apart, largely in shear, as the internal pressure took effect ballistically to hurl the fragments outward.

Figures 6 and 7 are photographs of a small section taken from a fragment. Figure 8 is a photograph of a section from the high pressure separator shell.

It is known that ferritic steels may fracture with low ductilities when subjected to certain specific conditions of loading, particularly at ambient atmospheric and lower temperatures. This change in the mode of fracture from the normally ductile or shear type usually exhibited at or above about room temperature, as in a tensile test, to the brittle or cleavage type, occurs over a range of temperature called the "transition temperature." Within the "transition temperature range" fractures usually are cleavage type toward the center of the plate with varying amounts of a zone of ductile fracture, called a "shear lip," toward the plate surfaces. Above the transition temperature range, energy absorption plots as a high plateau on an energy to fracture vs. temperature chart and below the transition temperature range energy absorption plots as a low plateau. At the present time most studies of the transition temperature properties of steel utilize an impact load applied at the center of a

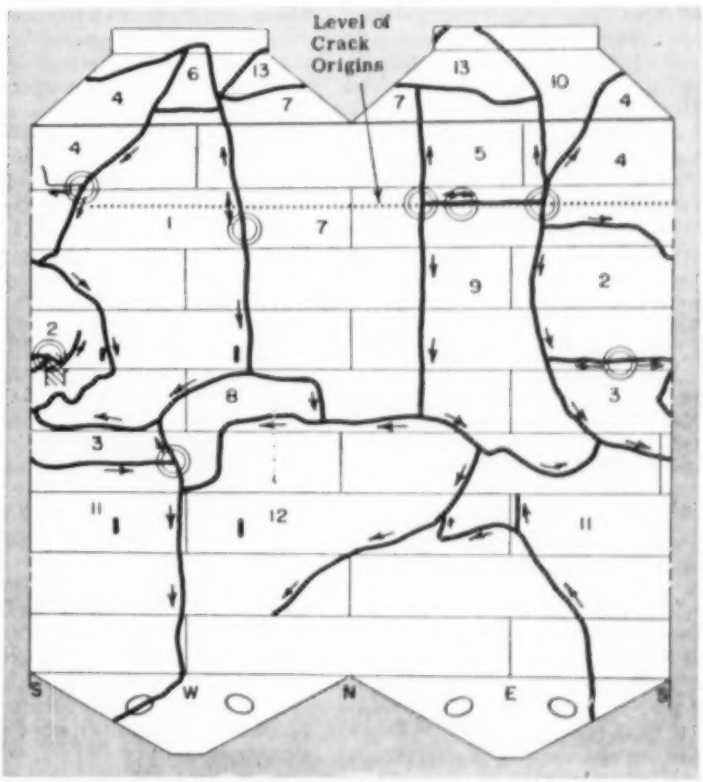


Fig. 5. Diagrammatic sketch of rupture and fragmentation pattern of reactor, viewed from inside. Arrows indicate directions of crack propagation. Note multiplicity of crack origins shown by circles. Cross-hatched area (2) represents section shown in Figure 6.

notched specimen which is supported at each end. This is the so-called "Charpy" test, the results of which have correlated reasonably well with service experience. Various other specimens and types of loading have been used; transition temperature data from these do not always correlate well with the Charpy data or with service experience.

Although much has been learned about the transition temperature characteristics of ferritic steels, much has yet to be clarified. It is known, for example, that it takes considerably more energy (probably a thousand times as much) to force a shear (or ductile) crack to run as fast as a cleavage (or brittle) crack. Furthermore, with a shear fracture this rate of running must be continually forced; if it is not forced, that is, if sufficient energy is not applied continuously, the crack will slow down and stop as a result of the high energy absorption needed to propagate it. This high energy absorption is the result of the metal deforming plastically before it ruptures in shear, sometimes with a sizable decrease in cross section, i.e., the steel sometimes necks down before fracturing. On the other hand, a completely cleavage fracture shows no signs of change in section. In addition a cleavage crack will run at speeds of up to about 5,000 ft./sec., or about one third of the velocity of sound in the steel (which is roughly, 15,000 ft./sec.). In fact, when a cleavage crack forms, the elastic energy released is at least equal to the energy required to keep the crack extending or running. This is not true of a ductile or shear crack by several orders of magnitude.

It is known also that most cleavage fractures exhibit a herringbone or chevron pattern which points back toward the crack origin. However, if the temperature is low enough, the herringbone markings do not appear.

The appearance of the fracture faces on the pieces from the reactor and the high pressure separator vessels was typical of what is known as a brittle- or cleavage-type failure. The fracture faces were at right angles to the plate surface, and in general, they had a bright crystalline appearance, with only a slight shear lip and necking down near and at the plate surface. Only a small part of the entire fracture lengths exhibited shear, such as is shown in Figure 6.

There is no present standard for transition temperature and there are no requirements covering it in any existing specifications of elevated temperature materials. For convenience, many investigators have used the nominal transition temperature at which a Charpy impact specimen absorbs 15 ft.-lb. of energy to fracture. Other investigators have used the half-energy level, i.e., the temperature at which the energy absorption of the Charpy impact specimens is half way between the highest and lowest energy absorption values measured over the range of testing temperatures. Still other investigators have used the 50% cleavage level, i.e., the temperature at which the Charpy (or other) specimen exhibits 50% shear and 50% cleavage in the fracture appearance.

Although these different transition temperatures may vary, and in many cases show no definite correlation with the actual temperatures at which engineering structures have failed, they do indicate trends and frequently they will classify steels in terms of increasing resistance to brittle fractures. This characteristic is termed notch-resistance, since in almost all instances a metallurgical (i.e., structural discontinuity) or mechanical (physical gap in the material) notch is necessary to provide the stress-concentration factor which triggers-off or initiates a crack. Obviously, notch-resistance is a relative characteristic. A material is said to be notch-resistant if, at its service temperature, impact-type loads will either not produce a crack or, if the load is high enough or imposed fast enough, the crack which forms will not propagate in a brittle manner.

Normally, brittle fracture is associated with low ambient temperatures. Most of the well-publicized failures of welded ships during World War II, and the less-publicized failures of engineering structures as presented by Professor Shank (*2*), had the common denominator of low ambient (winter, generally) temperatures. Some of these failures took place during a period of a relatively rapid change of temperature; this may have contributed a portion of the stress necessary to initiate and possibly even to propagate the brittle fracture.

The problem of brittle fracture has been a consideration in storage tank design and construction, and it has been discussed on many occasions. On the other hand, few have believed that a similar problem might or could exist in unfired pressure vessels. These vessels normally operate at elevated temperatures, well above the range over which most ferritic steels exhibit cleavage fractures. However, the process of heating such vessels to operating temperatures during start-up is gradual. The studies made of the steels used in the reactor and the high pressure separator indicate that these materials probably were in their transition ranges when failure took place. The data show that the steels used in these vessels exhibit rather high transition temperatures, based on Charpy impact tests, and on the 15 ft.-lb., the half-energy, or the 50% cleavage fracture criteria. It is interesting to note that full thickness Charpy-type specimens from the reactor shell showed a higher transition temperature than was found from tests on standard size Charpy bars. This points up the known increase in transition temperature associated with increase in plate thickness due, in part, to greater triaxiality of stresses and therefore, greater stress concentration at the root of the machined notch in the larger specimen. In general, this increase in transition temperature with plate thickness is believed to be of the order of 40° F. for each increase of 1-in. in plate thickness.

It should be emphasized that impact properties and transition temperature properties, have not been and are not now a requirement of steels used in unfired pressure vessels, unless such vessels are designed to operate at temperatures below −20° F. The relatively high transition temperatures of the steels used in the reactor and the separator are significant only insofar as they influence the probable manner of fracture under the excessive loading which caused the failure. The vessels undoubtedly would have failed, regardless of the metal used or its transition temperature, as a result of the forces exerted by the explosion and shock wave. The manner of failure might have differed with other materials but this could have been more or less serious than the present failure.

Notation

ρ = density, lb./cu. in.
h = wall thickness, in.
g = acceleration of gravity, in./(sec.)(sec.)
t = time, sec.
T = natural period, sec.
r = radial motion, in.
R_o = initial inside radius, in.
P = magnitude of the pressure pulse, lb./sq. in. gauge
E = Young's modulus of elasticity, lb./sq. in.
σ = stress in pipe wall, lb./sq.in.
y = yield point stress, lb./sq.in.
K = spring constant, lb./in.
m = mass of unit area of pipe wall, lb.(sec.)(sec.)/(in.)
P_y = static pressure which will produce yield point stress in the pipe wall, lb./sq.in. gauge

Literature Cited

1. Morrison, R. B., "A Shock Tube Investigation of Detonative Combustion," University of Michigan (1955).
2. Shank, M. E., *Proc. Am. Petroleum Inst.*, Section III (Refining), p. 131-42 (1954).

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estimation of DIRECT OPERATING LABOR REQUIREMENTS for new manufacturing processes

A method is described which, although less detailed than time-and-motion study, is thought to be a satisfactory alternate to guide management decisions on the labor aspect of new product evaluation.

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The estimation of direct operating labor requirements for new manufacturing processes plays an important role in the economic evaluation and production plans for new products. The magnitude of importance will depend to some degree upon the nature of the operation and the relationship of the labor figure to the over-all estimated manufacturing cost. Estimation of labor will be greatly influenced by the nature of the process as developed by Research, the design of the operating units and plant layout by Engineering, and last but by no means least, the experience factor obtained from similar or related operations.

It should be noted that the procedure for an existing process is quite similar to that used for a new process except that in the former case the experience factor plays a more important part. In plants with labor organizations, provisions of the union contract may be an important consideration also in the estimation of the operating work force.

It is recognized that time-and-motion study is a highly developed branch of engineering in its own right. The method described herein for estimating labor and equipment requirements is less detailed than most time-and-motion-study techniques. However, this procedure is considered to be a satisfactory alternate and will serve as a guide for:

1. Estimating labor and equipment requirements for a new manufacturing process.
2. Determining capacity and work load for existing manufacturing processes.
3. Providing a basis for discussions with a union committee covering the size and classifications of the work force needed for a given operation.

The ideas for a new chemical product, a major process improvement, or a significant expansion of an existing process will normally originate in the Research Department. Following the preparation of the proposed process description, the project is turned over to Engineering for a preliminary estimate of the capital requirements and, jointly with Production, a manufacturing cost estimate is made. If the preliminary evaluations indicate that the economics of the process are favorable and the capital authorization is approved, Engineering completes the process and mechanical design necessary for construction.

From the process description, including operating cycles and a preliminary layout and flow sheet of the process, there is normally sufficient information for estimating the labor requirements for the manufacture of the new product. An estimate made at this stage may, however, require revision at a later date when engineering design has progressed sufficiently to indicate that some changes in allocation of manpower or assignment of operating duties are desirable or necessary.

For the purposes of the procedure used in estimating the labor requirements, the following definitions of terms are established:

Defining Terms

- *Process step*—Any unit process, unit operation, or any combination of either or both which takes place in one piece of equipment or in one integrated group of equipment, on a repetitive cycle or continuously. The individual process steps make up the complete manufacturing process.
- *Operational step*—Anything done or initiated by the operating personnel to perform the process step. Each operational step will require equipment time and/or operator time.
- *Full rate of the equipment*—For a particular process step, the maximum number of batches per day that can be produced when there is no idle equipment time between batches.
- *Full rate of the department*—For a particular process step the average number of batches per day produced when operating at the maximum capacity of the manufacturing process.

In carrying out the procedure two

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Table 1.

Manpower and Equipment Utilization Analysis

Form 1.

Dept.: 1 | Product: Chemical A | Analysis by: XYZ

Process Step: Chlorination | Batch size: 1,100 gal. crude = 4,000 lb. finished product (3 chlorinator batches = 1 fractionation batch) | Date: 5/1/57

(1)	(2)		(6)		
Operational steps	Equipment utilization		Manpower utilization		
	Elapsed time hr.:min./batch	Remarks	Working time hr.:min./batch		Remarks
1. Charge head tank with raw material	0	Done while previous batch is chlorinating	0:10 0:20	A	Start and stop pump, open and close valves Sample and take to lab
2. Service dryers	0	Done while previous batch is chlorinating	0:10	B	Drain brine to sewer
3. Charge chlorinator with raw material	0:30	Estimated	0:15	C	Open valves, drop in raw material Close valves
4. Charge gas scrubber	0:05	Estimated	0:05	D	Pump out old charge, drop in fresh charge
5. Start chlorination	0:20	Avg. of 50 log sheets	0:20	E	Open gas valves, line up cooler flow, adjust temperature
6. Chlorinate batch	5:30	Avg. of 50 log sheets	1:30	F	Check specific gravity and take readings 6 times @ 15 min. each
7. Shut down chlorination and pump out batch	0:35	Estimated	0:10	G	Line-up valves, start pump, close valves

		(3)	(4)	(5)		(7)	(8)
	Total batch cycle, hr.	Batches/24 hr. full rate of equipment	Batches/24 hr. full rate of department	Equipment use rate in % (4)/(3)	Total man-hours/batch	Man-hours/24 hr. full rate of equipment (3) × (6)	Man-hours/24 hr. full rate of department (4) × (6)
Total	7.00	3.43	2.35	69%	3.00	10.29	7.05

Letter code in column 6 refers to Fig. 1, Form 2

types of forms are used in the preparation of a work load and equipment utilization analysis to arrive at the work-force requirements. These are:

Form 1. **The Manpower and Equipment Utilization Analysis.**

Form 2. **The Men-Equipment Time Chart.**

A separate Form 1 is completed for each process step. A single Form 2 shows all the process steps which are grouped together to constitute an operating job for one man or one crew.

The degree of subdivision of operational steps for any process step is left to the discretion of the analyst. In general, greater detail is desired for short-cycle steps such as packaging or centrifugation than for long-cycle steps such as chlorination and distillation.

In estimating work load for a new manufacturing process, the man-hours for individual operational steps may be estimated from experience with analogous operations or judgment. Elapsed time for the operational steps will be based generally on engineering calculations—rates of flow, reaction, and heat transfer.

In an analysis of work load and equipment usage on an existing manufacturing process, data are generally obtained from operating log sheets, or first-hand observation of the process. A word of caution—blind acceptance of operating log-sheet figures can be misleading. First-hand observation of several representative cycles is recommended to insure that log-sheet information is accurate.

A detailed description of the procedures used in completing Forms 1 and 2 follows. Hypothetical examples of completed forms shown in Tables 1, 2, and 3 for Form 1 and Figure 1 for Form 2 are batch processes. However, the analysis is equally applicable to continuous operations with the units changed from batch size and batch cycle to daily production and daily time requirements.

Manpower and Equipment Utilization Analysis

Completion of the Work Load and Equipment Utilization Form for each process step develops the following:

1. Process step batch cycle.
2. Maximum number of batches per day that can be produced at full rate of equipment used for the process step.
3. Number of batches per day required at the full rate of the department.
4. Equipment use rate at department capacity.
5. Total man-hour requirements for each batch.
6. Total man-hours required per day operating at the full rate of the equipment.
7. Total man-hours required per day operating at the full rate of the department.

Where operating personnel operate only one process step, the manpower requirements can be obtained directly from this form. Where more than one process step is involved, manpower requirements can be determined only after completion of the Men-Equipment Time Chart has indicated that operational conflicts do not exist.

Table A.

Table No.	Process step	Batch size (lb. finished product)	Batch cycle, hr.	Capacity lb./day at 100% equipment use
1.	Chlorination	4,000	7.00	13,700
2.	Preliminary distillation	4,000	6.92	13,900
3.	Fractionation	12,000	30.66	9,400

Tables 1, 2, and 3 indicate the use of the standard form in developing a Manpower and Equipment Utilization Estimate.

To complete this form, the procedure is as follows:

- In col. 1, each operational step is tabulated, in the order performed, to complete the subject process step.
- In col. 2, opposite the corresponding operational steps, the elapsed equipment time to accomplish these steps is recorded. Under "Remarks" a description is entered indicating how these times were obtained (e.g., average of 50 batch records, observation, estimated, etc.).
- In col. 6, opposite the corresponding operational step, the working time required by the operator to complete this step is shown. This includes physical labor, observation of temperatures, data recording, sampling, and calculating. Under "Remarks" the various duties included in apportioning the time are indicated.
- The sum of the operational step equipment time items in col. 2 constitutes the batch cycle.
- In col. 3 is recorded the number of batches which can be produced/24 hr. at the full rate of the equipment. This number is obtained by dividing the batch time cycle into 24 hr. Example (Table 1): batches/day = 24 hr./day/7.00 hr./batch = 3.43 batches/day.
- In cols. 4 and 5 are recorded the number of batches which can be produced/24 hr. at the full rate of the department and the equipment use rate. To arrive at the latter figure, the department bottleneck must be known. Table A gives an example.

Thus, fractionation is the bottleneck and the use rate for the chlorination equipment is $9{,}400/13{,}700 \times 100 = 69\%$. Then the number of chlorinator batches per day is 69% of 3.43 or 2.35 batches at the full rate of the department.

- The sum of operational step man-hours in col. 6 will constitute the labor man-hours required for one cycle of the process step.
- In col. 7, the man-hours of operating labor required at full rate of equipment are computed by multiplying man-hours/batch (col. 6) by batches/day (col. 3).
- In col. 8, the man-hours of operating labor at full rate of the department are determined by multiplying man-hours per batch (col. 6) by batches per day (col. 4).
- Where the department being studied consists of several process steps, the above procedure is followed for each process step. The sum of the total hours in col. 8 for all process steps then will indicate the total man-hours of operating labor per 24-hr. day required to perform the job at the full rate of the department. Table B gives an example.

Table 2.

Manpower and Equipment Utilization Analysis

Form 1.

Dept.: 1 — Product: Chemical A — Analysis by: XYZ

Process Step: Preliminary distillation — Batch size: 1,100 gal. crude = 4,000 lb. finished product (3 preliminary distillation batches = 1 fractionation batch) — Date: 5/1/57

(1) Operational steps	(2) Equipment utilization: Elapsed time hr.:min./batch	Remarks	(6) Manpower utilization: Working time hr.:min./batch		REMARKS
1. Fill still pot	0:30	Estimated	0:15	H	Open valves, observe level, close valves
2. Start distillation	0:15	Estimated	0:15	J	Apply vacuum, turn on steam
3. Distill batch	6:00	Calculated from last production run	1:00	K	Check rate, read temperature, and adjust feed 6 times/batch, @ 10 minutes each
4. Shut down still	0:10	Estimated	0:10	M	Turn off steam, bleed vacuum
5. Drop receiver to storage tank	0	Done while charging still for next batch	0:10	N	Open valves, close valves, measure tanks

	Total batch cycle, hr.	(3) Batches/24 hr. full rate of equipment	(4) Batches/24 hr. full rate of department	(5) Equipment use rate in % (4)/(3)	Total man-hours/batch	(7) Man-hours/24 hr. full rate of equipment (3) × (6)	(8) Man-hours/24 hr. full rate of department (4) × (6)
Total	6.92	3.47	2.35	68%	1.83	6.35	4.30

Letter code in column 6 refers to Fig. 1, Form 2

Table B.

Process step	Table No.	Man-hours/24 hr. at full rate of Department
Chlorination	1	7.05
Preliminary distillation	2	4.30
Fractionation	3	5.28
Total		16.63

Men-Equipment Time Chart

The Men-Equipment Time Chart is intended to show the sequence and scheduling of operational steps. It indicates where conflicts may prevent simultaneous operation of several pieces of equipment.

The form which this time chart takes is best determined by the job being analyzed. Consequently, no blank form is provided, but an example is shown in Figure 1. This chart should include all process steps and all men associated with them for a given job or interrelated group of jobs. In most cases, this will be a single operator; and in some, it will be an operator and a helper, or several operators.

In making this illustration the following procedure is used:

1. A convenient time scale is chosen and shown. For short-time, repetitive operations, such as batch centrifugals, the scale will normally be in minutes. For most chemical operations, the scale usually will be in hours, with at least 24 hr. shown on the chart. For extremely lengthy batch cycles a smaller scale is used so that at least one complete cycle of operation is covered.
2. Column headings are designated for each man and each machine or process step.
3. Cross-hatching and shading reveal the breakdown of the operational steps for each process step. On the side of each column the operation covered is indicated by a code letter which refers to the appropriate Form 1.
4. The working time, positioned to show when it occurs, is entered for each man.
5. Whether a new operation is being estimated or an existing one analyzed, some adjusting of operating schedules may be required to arrive at the most productive or economical arrangement.

For most effective use of manpower it is important that full consideration be given to the use of process control instruments. After completing the Manpower and Equipment Utilization Analysis and the Men-Equipment Time Chart, it may be found that conflicts exist between operational steps or that the work-load analysis indicates the need for a fraction of another man per shift. In such cases a critical review of the process should be made to determine where proper instrumentation could be utilized to eliminate either one or both of these problems.

It should be pointed out also that the use of certain equipment items of greater capacity or different design, the use of hold tanks, or some revisions in process layout may be justified in order to eliminate operating conflicts or to achieve the most effective utilization of manpower.

Acknowledgment

The author acknowledges the assistance of M. P. Lux, assistant superintendent, Technical Services Department, and J. M. Trebilcock, production supervisor, Monsanto Chemical Company, Monsanto, Illinois, in preparing the material for this paper.

Presented at A.I.Ch.E. meeting, Baltimore, Maryland.

Table 3.

Manpower and Equipment Utilization Analysis

Form 1.

Dept.: 1 | Product: Chemical A | Analysis XYZ

Process Step: Fractionation | Batch size: 3,300 gal. crude = 12,000 lb. finished product | Date: 5/1/57

(1) Operational steps	(2) Equipment utilization: Elapsed time hr.:min./batch	Remarks	(6) Manpower utilization: Working time hr.:min./batch		Remarks
1. Fill still pot	0:30	Estimated	0:20	P	Open valves, check level, close valves
2. Heat up still	0:30	Estimated	0:10	Q	Apply vacuum, turn on steam, put on total reflux
3. Reflux	0:30	Specified in operating instructions	0:05	R	Check temperature and pressure
4. Distill batch	28:30	Calculated from boil-up rates	3:00 2:00	S T	Take 18 readings @ 10 minutes each Switch receivers 4 times @ 30 min. each
5. Shut off still	0:10	Estimated	0:10	U	Turn off steam, bleed vacuum
6. Drop residue	0:30	Estimated	0:30	W	Open and close valves, observe draining
7. Sample finished product and pump to storage	0	Done while next batch is being distilled	0:30	X	Sample finished product and take to lab Pump to storage

	Total batch cycle, hr.	(3) Batches/24 hr. full rate of equipment	(4) Batches/24 hr. full rate of department	(5) Equipment use rate in % (4)/(3)	Total man-hours/batch	(7) Man-hours/24 hr. full rate of equipment (3) × (6)	(8) Man-hours/24 hr. full rate of department (4) × (6)
Total	30.66	0.78	0.78	100%	6.75	5.28	5.28

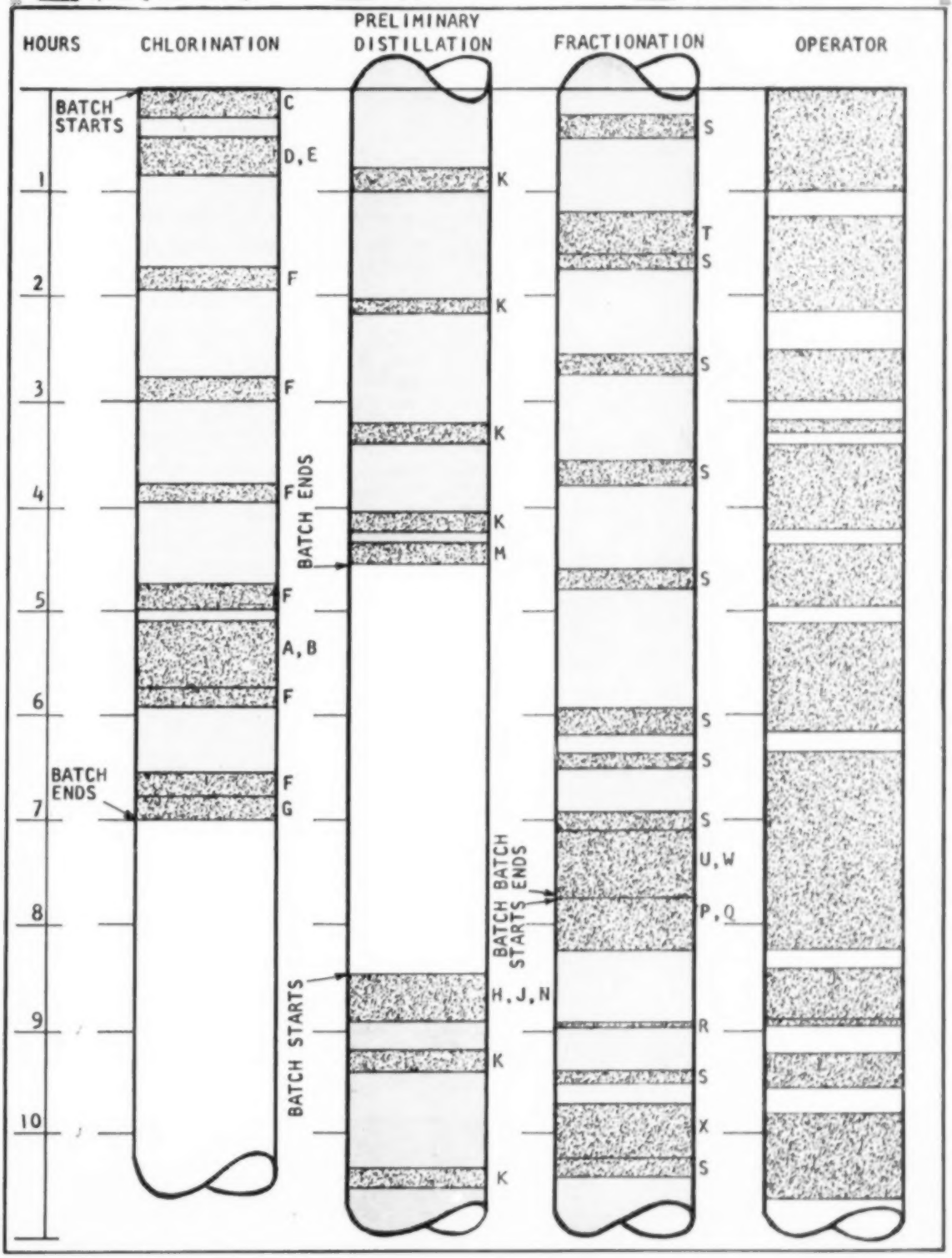
Letter code in column 6 refers to Fig. 1, Form 2

Fig. 1. **SECTION OF A MEN-EQUIPMENT TIME CHART** Form 2

Dept.: 1 Product: Chemical A Job: Premium operator Analysis by: XYZ

Legend (for letter code refer to Tables 1, 2, and 3): Date: 5/1/57

operating and recording | equipment "on" | free or idle time



development of an

AGITATED TROUGH CONTINUOUS CALCINER

M. J. Szulinski | General Electric Company
Hanford Atomic Products Operation, Richland, Washington

A troublesome and costly step in the purification of uranium is simplified by development of a practical continuous trough for the calcination of uranyl nitrate hexahydrate.

Uranium purification processes usually result in a solution of uranyl nitrate hexahydrate, commonly called UNH. Further processing generally involves a calcination of the UNH to uranium trioxide, UO_3. It is the calcination step with which this article is concerned.

Classically, the solution of UNH is concentrated to the molten salt, a clear liquid which freezes at 60° C. The liquid is loaded into agitated pots or kettles which are heated until the nitrate is decomposed and the dry, powdery solid oxide remains. All combinations of molten UNH, uranium nitrates, and UO_3 obviously occur, and at one point, a so-called mastic stage, agitation becomes extremely difficult. The process usually results in a hard cake of UO_3 on the agitator surfaces as well as a finely divided powder. The caked material is difficult to remove and much manual labor is required to unload the pot with pneumatic gulping tubes. These handling problems, cost considerations, and an occasional foam-over of the pots caused by trace amounts of organic impurities were sufficient incentives for the development of processes and equipment to calcine uranyl nitrate hexahydrate in a continuous manner.

Planning Operation

A strong process requirement appeared to be the avoidance of the mastic stage to eliminate caking. This is complicated by the fact that UO_3 is significantly soluble in molten UNH. To accomplish the desired end, several schemes of operation that depended upon a rapid denitration or upon mixtures of UNH and UO_3 and that did not become mastic were scouted. These were:

Spray drying
Drum drying
Fluid bed
Moving bed with external mixing
Heated screw with external mixing

In the course of the preliminary investigations, it was decided that mixing UNH with UO_3 and calcining in the same equipment appeared most promising. Other schemes were eliminated on the basis of the complexity of solids handling or the necessity for recirculating gas systems. The latter criterion arises from the fact that in addition to economical heat utilization in a system dependent upon gas-to-solid heat transfer, the off-gas must be suitable for economical recovery of the nitrogen oxides as nitric acid.

In order to test the feasibility of mixing UNH with UO_3 and calcining in a single piece of equipment, the trough of a screw conveyor 4 in. diam. by 44 in. long was fitted with a paddle-type nonconveying agitator in place of the conventional screw. A discharge fitting was provided on one end such that a level of agitated powder could be maintained in the trough. Preliminary tests indicated that good agitation was obtained with the agitator about three-fourth submerged, rotating at about 140 rev./min. With appropriate heaters external to the trough, and with product-collection and gas-removal facilities, molten UNH was fed to the top of the bed at three points at controlled rates to maintain a powder temperature of 300°C. as measured by thermocouples inserted in the bed at the point of feed introduction. It was found that the reaction was easily controlled and that the character of the powder changed from the finely divided pot-produced starting material to an essentially dust-free material composed of spheroids averaging about 150 μ in size. The bed, at 300°C., remained essentially dry during operation thereby avoiding the mastic stage, and agitation appeared adequate to prevent agglomeration of particles. With the top entry of the feed, however, there was a tendency for the UNH and UO_3 to splatter onto the walls of the calciner and to deposit there, above the powder level, as hard lumps. A redesign of the feed system, to inject the feed under the powder level, resulted in trouble-free operation.

Scouting tests indicated that the powder bed was essentially dry when operated with temperatures over 230° C. at the point of feed injection and that operation with temperatures as low as 150° C. was possible if the temperature between feed injectors was allowed to reach temperatures adequate to complete the denitration. At these lower temperatures, however, the mixture was wet and approaching

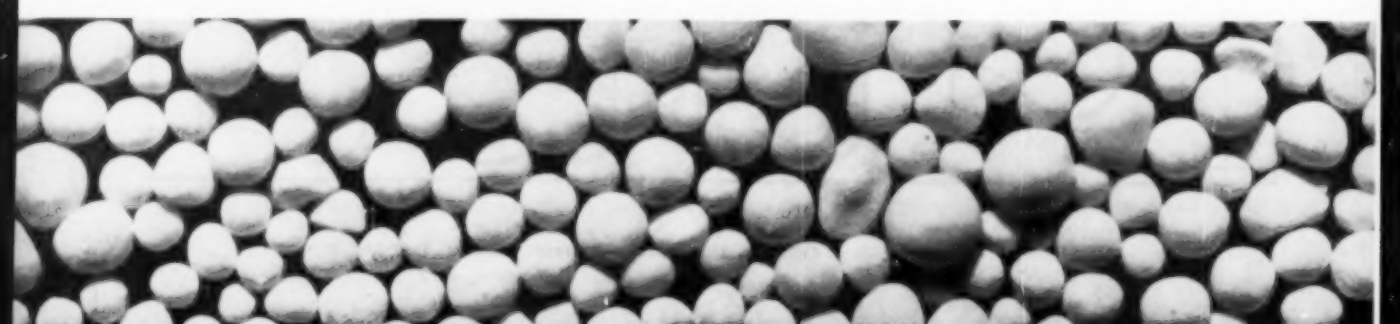


Fig. 3. Prototype continuous calciner (left). ►

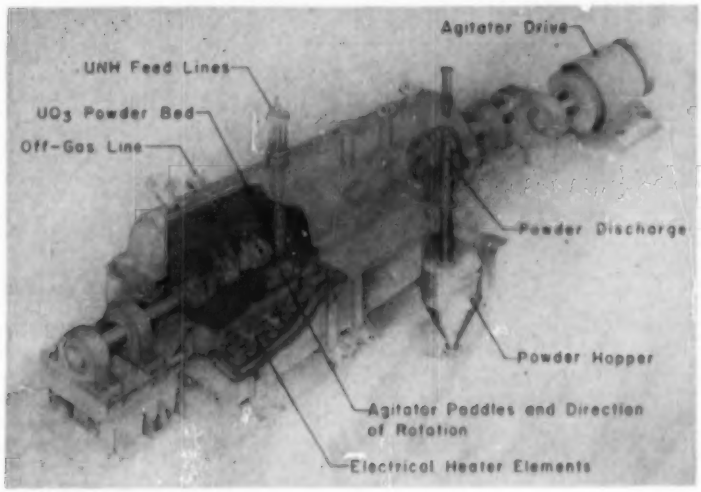
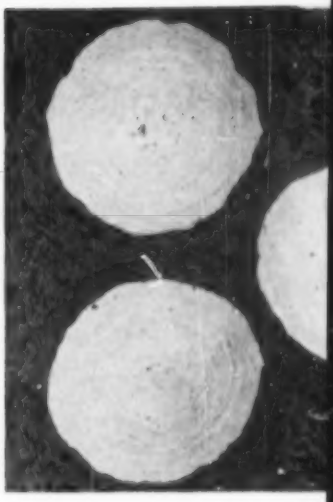


Fig. 8. A cross section of the particles (right). ►



the mastic stage—an undesirable condition.

The power required to rotate the agitator at various levels of trough loading was determined as approximately proportional to the third power of the weight of UO_3 in the rotated cross section at any given speed under 140 rev./min. and directly proportional to agitator speed at any given bed level up to 140 rev./min. Agitator speeds in excess of 140 rev./min. were not investigated. The equipment, as evolved in development, was not amenable to accurate heat transfer evaluation. Over-all performance, however, appeared to be sufficiently satisfactory to warrant the design and further evaluation of a scale-up model calciner.

Equipment

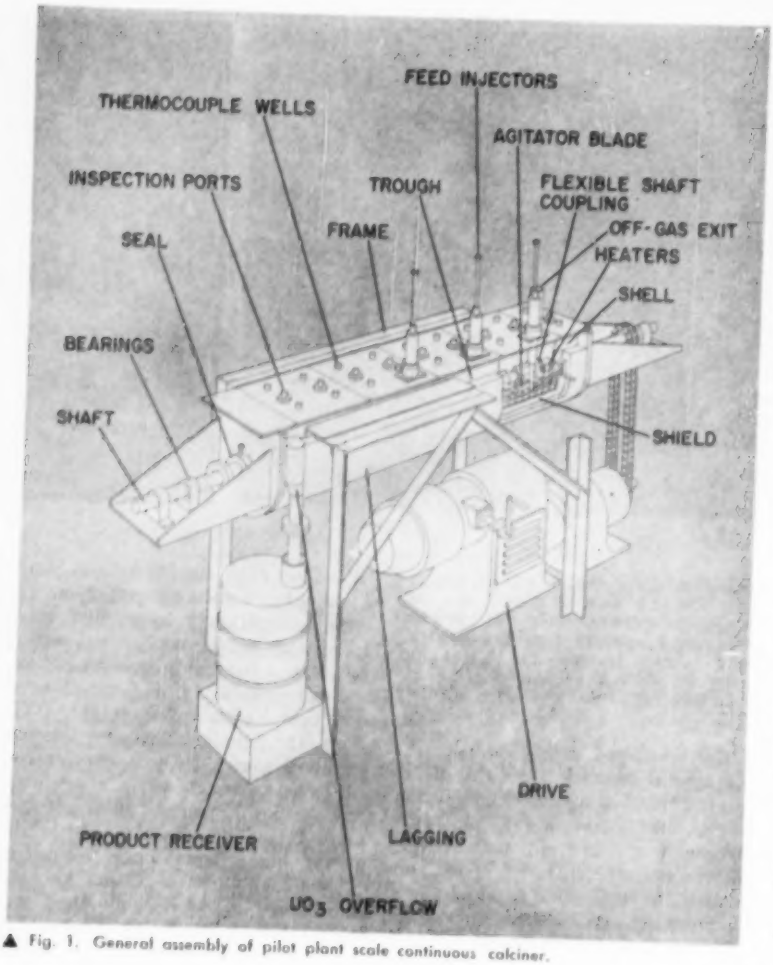
A calciner with a trough 16 in. diam., 24 in. high, and 8 ft. long was designed, fabricated, and installed. This unit is shown in Figure 1. The UO_3 was agitated by means of a T-bar scraper-blade-type agitator located concentrically with the trough. The level of the bed was maintained in the calciner by means of an overflow weir such that the agitator was approximately 70% submerged. Heat was provided by means of thirty-six tubular heaters, each rated at 2,650 w. and grouped in four banks of nine external to the trough. The power input to each group of heaters was separately controlled by variable transformers. The UNH feed was added to the bed at three points through steam-jacketed feed injectors located in the middle of three controlled heat zones. The fourth heated zone was located at the discharge end of the reactor and was used to control the discharge temperature of the powder. Operating conditions were controlled by thermocouples located in the UO_3 at each feed point and at the discharge end. Material of construction was 304-L stainless steel.

The flow sheet of the development operation is shown in Figure 2. UNH was received as a 60% solution and concentrated to the molten salt. This material was stored in a tank at temperatures above the freezing point and pumped to the calciner through a steam-traced loop header. An aliquot was withdrawn from the header and metered to the calciner manually by means of rotameters heated electrically to temperatures above the feed melting point. The product was collected directly in drums. The off-gas was withdrawn from the calciner at the end opposite the product discharge by means of a steam-operated jet. Dust was collected for measurement in most runs with a turbine-type centrifugal separator, or was returned to the calciner after collection on a wire cloth filter.

During the initial stages of operation, it was estimated that agitator speed required would be related to the peripheral velocity. The 16-in. unit was started up, therefore, with an agitator speed of 37 rev./min., matching the 2.5 ft./sec. tip velocity of 140 rev./min. on the 4-in. calciner. Heat transfer under these conditions was poor. Localized hot spots developed on the trough resulting in severe distortion. Increasing the agitator speed to 80 rev./min., however, improved heat transfer remarkably, and the calciner was operable at rates up to 13,000 B.t.u./(hr.)(sq.ft.). At the slower agitation speeds the heat transfer coefficient between the inner trough wall and the powder ranged from about 5 to 10 B.t.u./(hr.)(sq.ft.)(°F.) while at the higher speeds the coefficient ranged as high as 47. With an agitator speed of 80 rev./min. and bed temperatures between 230 and 295° C., coefficients were between 24 to 47 B.t.u./(hr.)(sq.ft.)(°F.). Good heat transfer was maintained indefinitely at these operating conditions and did not appear to be affected by a loose thin scale of UO_3 on the trough wall. At higher temperatures, 350° C., erratic heat transfer was again experienced leading to heat fluxes restricted by trough distortion.

Several agitator designs were tested in the course of development. The most satisfactory was a nonconveying T-bar type consisting of twelve blade assemblies positioned on a 3½-in. diam. shaft. The blades were 2 in. wide and from 6 to 14 in. long, depending upon their location. Each assembly of two blades was placed at equal intervals around the circumference of the shaft so that only one agitator blade entered the powder at any instant. A 2-in. spacing between blades provided for the placement of feed injectors and

▼ Fig. 7. A photomicrograph of the product.



▲ Fig. 1. General assembly of pilot plant scale continuous calciner.

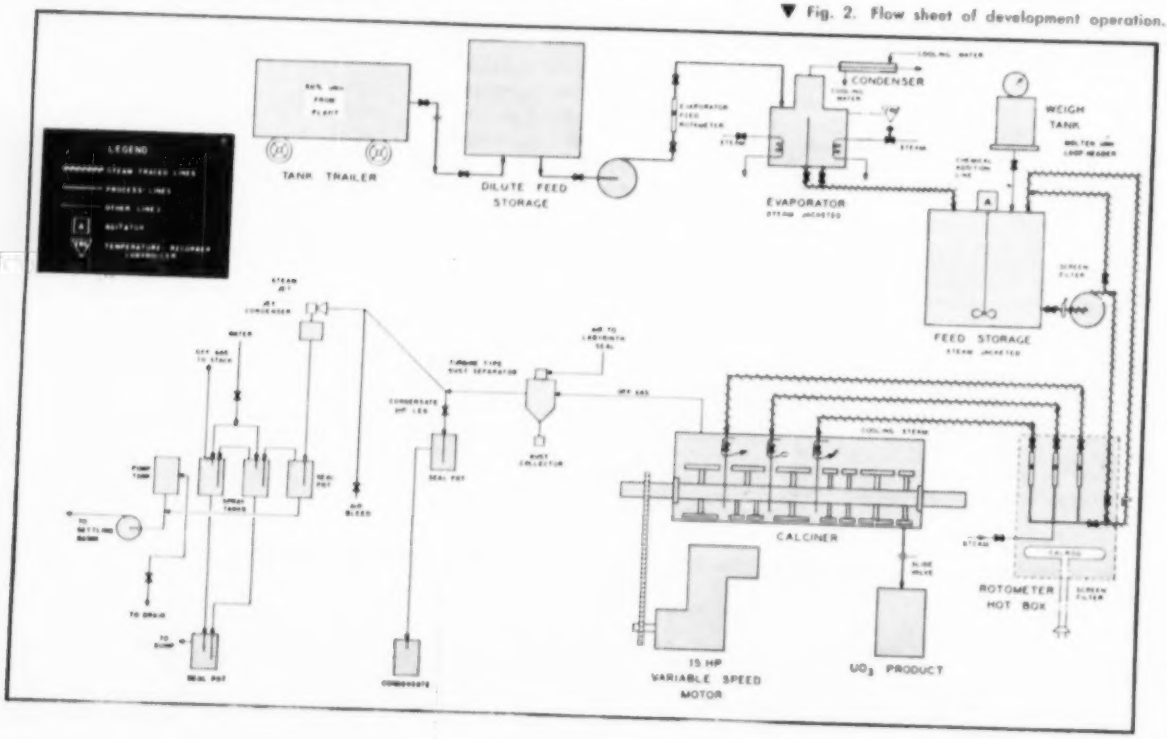
thermocouples. The agitator shaft was supported by stub shafts, each of which was positioned by a double bearing assembly external to the calciner end plate. Flexible butterfly-type shaft couplings were located within the calciner. The agitator was driven by a 15 hp. U. S. Varidrive with speed variable over the range of 20 to 100 rev./min. With the calciner loaded with 2,180 lb. UO_3, the running torque was estimated at 11,000 to 17,000 in.-lb. and was essentially constant over the range of 20 to 80 rev./min. Starting breakaway torque was 200% of the running torque. It was also found that the power of agitation appeared as useful heat in the bed. Although the shaft seals initially presented a powder-leakage problem, a conventional stuffing box, packed with aluminum foil packing (Durametallic type D-10) and pressurized with air through a lantern ring, proved highly satisfactory. The agitator used in these tests is shown in Figure 6. Although designed for possible use of four blades at each position, two were found to be adequate.

Three feed injectors located 21 in. apart were used on the calciner. These were placed on the side of the agitator such that the UNH-UO_3 mixture was carried away from the injector as the blades passed downward. The optimum point of discharge was found to be slightly below center line of the agitator. It was necessary to jacket the feed injectors with low-pressure steam to prevent pluggage caused by denitration of the feed at ambient bed temperatures. The calciner, with the top cover insulation removed, is shown in Figure 5.

During operation less than 1 wt. %, usually 0.2%, of the product was entrained into the off-gas as dust.

The uranium trioxide produced in the agitated trough continuous calciner

▼ Fig. 2. Flow sheet of development operation.



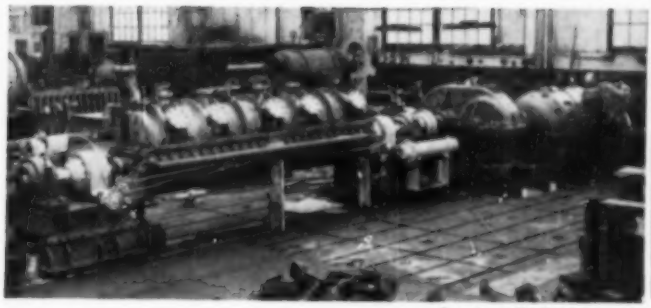


Fig. 4. Continuous calciner under construction in the shop. *Struthers Wells Corp.*

Fig. 5. Same calciner with top cover insulation removed.

differs markedly in physical appearance from oxide produced in pots. Continuously produced UO_3 is a relatively dense, free-flowing material made up of essentially spherical particles. The angle of repose of the material was measured to be approximately 26 degrees from the horizontal (see Figure 9). The nitrate and water content of the UO_3 varied according to the temperature of calcination. The nitrate ranged from 1.1% at 230° C. to 0.02% at 450° C. Water content ranged from 2.6% to 0.1% at the same temperatures. A photomicrograph of the product and a cross section of the particles are illustrated in Figures 7 and 8.

Testing a Full-size Unit

Again, at this point, the equipment performance was sufficiently attractive to warrant testing a full-size unit. A prototype model was designed on the basis of the following criteria:

1. Drive requirements per unit length are proportional to the square of the arm length at constant peripheral velocity and at given loading geometry, and torque is constant at various agitator speeds.
2. Starting torque is 200% of the running torque.
3. Agitator speed must be such to result in 1 to 1.4 times gravitational acceleration at the periphery for adequate heat transfer. This was based on the fact that 140 rev./min. on the 4-in. unit and 80 rev./min. on the 16-in. unit resulted in centrifugal accelerations of 1.05 and 1.4 respectively.
4. The heat transfer coefficient from wall to powder of 25 B.t.u./(hr.)(sq.ft.)(° F.) was assured and 40 was likely.

On the basis of such criteria, a calciner, 26-in. I.D. by 12 ft. long, powered by a 150 hp. variable speed a.-c. motor and heated by a 175-kw. furnace, was constructed and operated. An agitator speed of 60 rev./min. was predicted. Scale-up estimates of required agitator revolutions per minute and horsepower were verified. Heat transfer from the powder bed to the shell wall was satisfactory in the range of 60 to 70 rev./min. agitator speed, but was inadequate below 55 rev./min. as indicated by heat distortion of the shell wall.

Drive requirements of 80 to 95 hp. at 60 rev./min. were close to the calculated 90 hp. Heat transfer coefficients as high as 35 B.t.u./(hr.)(sq. ft.)(° F.) at heat fluxes up to 12,500 B.t.u./(hr.)(sq.ft.) have been measured. The UO_3 product is similar to that produced in the smaller units. The prototype calciner is shown in Figure 3, and Figure 4 illustrates the same calciner under construction in the shop of the Struthers Wells Corporation.

Conclusions

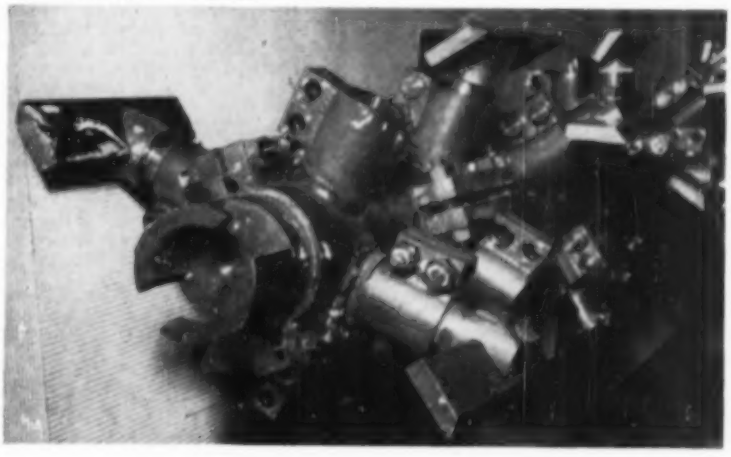
It was concluded from these studies that the agitated trough continuous calciner is a practical production unit for denitrating UNH to UO_3. Heat transfer is adequate with good agitation. Agitation is positive, preventing particle agglomeration, and is independent of particle size. Some advantages of continuous calcination over batch pot operation were shown to be:

1. avoidance of the mastic stage and minimizing of caking in the calciner
2. elimination of foaming of the charge
3. lower operating cost
4. more efficient nitric acid recovery because of the steady evolution of oxides of nitrogen from the continuous process.

Presented at A.I.Ch.E. meeting, Seattle, Washington

▲ Fig. 9. The angle of repose of the material.

▼ Fig. 6. An agitator showing the adequacy of two blades.



DRYING

viable biological materials by solvent/extraction and azeotropic distillation

R. R. Freeman, M. A. Auro, T. R. Dashiell, J. E. Murphy, I. Oshrine, and R. F. Smith | Chemical Corps, Fort Detrick Frederick, Maryland

The scope of standard chemical engineering techniques is illustrated by their application to the processing of extremely delicate biological materials.

Aqueous suspensions of certain viable biological materials may be dehydrated by replacing the water with miscible, low boiling organic solvents. The residual solvents used in the extraction process may be removed from the product by air drying at atmospheric pressure or by evaporation under reduced pressure.

A second drying process involves the distillation at reduced pressures of mixtures of aqueous biological suspensions with low boiling immiscible solvents. Water is removed as an azeotrope in the vapor phase. For a given set of operating conditions, the amount of water removed is dependent upon the solvent that has been selected. The application of the azeotropic process to the dehydration of viable materials was initially investigated by the United States Industrial Chemical Company under a contract with the U. S. Army Chemical Corps. Levin and Finn (*1*) also have applied the azeotropic process to the drying of animal and vegetable tissue.

Toxic Condition Determinant

The major criteria for the selection of the solvent for either process are the toxic effects of the solvent on the biological material and the characteristics of the resulting product.

Laboratory investigations of these methods for aqueous suspensions of the spores of *Bacillus subtilis var. niger* indicated that there was no significant difference in the product recovered from either drying process. The basis for this conclusion was the recovery of viable spores and the residual volatile contents of the product. The descriptions in the accompanying pages will show the similarity in the type of process equipment that is required despite the difference between extraction and distillation.

Based on pilot plant work performed at Fort Detrick, with acetone as the solvent, the following process design for a solvent extraction process was proposed.

Solvent Extraction Process

Figure 1 is a flow diagram of the solvent extraction process. A concentrated suspension of *Bacillus subtilis var. niger* in the amount of 125 gal. is slurried at room temperature in 400 gal. of acetone. Agitation is provided by an air-driven mixer for a period of 1 hr.

The blended slurry is pumped through a 50-gal. gravity feed tank equipped with an overflow return to the mixing tank. The feed tank supplies a double bank of 12 in. diam. filter pots arranged six on each side of a double-sided laboratory type hood. Hardened filter paper is used as the filtering medium. Vacuum is applied to the filter pots to aid the separation.

The 525 gal. of slurry are filtered in about 3½ hr. At the end of this step, the cake is manually scraped from the pots and placed on a stainless steel conveyor belt which runs between and slightly above the rows of filter pots. The end of the conveyor is positioned above the mixing tank so that the cake, when scraped from the belt by a doctor blade, falls into the tank for repulping. Solvent from the initial filtration is passed through the filter pot manifold to a wet acetone holding tank located below the filtration hood.

Fresh acetone (300 gal.) is charged to the mixing tank for this operation. Resuspended cake is blended for about 15 min. and the slurry is filtered again, the process consuming about 45 min. After each filtration the filter papers are placed in a small pot of acetone and agitated by hand to recover product. Acetone in the small pot is decanted into the mixing tank.

Resuspension and filtration are repeated through two more stages with the use of 200 and 100 gal. of acetone, respectively.

The dry cake is passed through an air lock and removed to a controlled humidity section of the hood system for further processing or packaging as required.

Spent acetone which has been accumulating in the holding tank is recovered by distillation. Water from the bottom of the distillation column is passed to the waste disposal system. The recovered dry acetone is stored in a tank and pumped back to the mixing tank as needed.

The design just described was made available to Merck and Company, Inc., who utilized it with some modifications under a contract with the U. S. Army Chemical Corps. The major equipment difference was in the use of a plate-and-frame filter instead of a bank of filter pots. Process differences included the use of a three-stage extraction instead of the four-stage extraction that is described here and a different solvent ratio.

The spore suspension that was used at Fort Detrick was moderately difficult to blend in the first stage. It became progressively easier to blend in each succeeding stage. Consequently, each leaching was found to require a smaller quantity of solvent than the preceding step.

In order to determine the amount of water removed at each stage of the process, laboratory drying runs were made and the filtrates from each stage were analyzed for water by the Karl-Fischer method. The results are given in Table 1. The percentages shown could not be based on the water in the

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original sample because of a small physical loss of solids during handling.

The residual volatiles content of the cake dried by the above process is relatively high, ranging from about 11-7%. If a further reduction in residual moisture is desired, additional drying in a vacuum oven is necessary. When a lower percentage of residual volatiles in the dry product was desired, the air drying step was eliminated and the cake was dried in a vacuum oven.

Laboratory samples of solvent wet filter cake were taken after the fourth extraction. The samples were placed in an oven for 24 hr. at 40° C. under the full vacuum available from a mechanical pump. An acetone-condensing trap was placed in the vacuum line between the oven and the pump to prevent damage to the pump. The vacuum ranged from 500 to 200 μ during each run. Samples were analyzed by a Cenco moisture balance every 4 hr. The resulting drying curves are shown in Figure 2. The presence of some residual volatiles after drying for 24 hr. in a vacuum oven indicates that the volatiles are bound within the spores or in the matrix of fermentation products surrounding the spores.

The presence of a small residual volatiles content was also noted in the material dehydrated by azeotropic distillation. During the laboratory phase of the contract, personnel of the United States Industrial Chemical Company screened about a dozen candidate solvents for use in the azeotropic distillation process. Criteria for the selection of a solvent included the absence of toxic effects on spores to be dried, immiscibility or slight solubility in water, cost, and a relatively high carry-over of water in the azeotrope in comparison with other solvents that were screened. Two of the solvents tested, *n*-butyl alcohol and *n*-butyl acetate, met the initial requirements satisfactorily.

Azeotropic Distillation Process

Figure 3 is a flow diagram of the azeotropic distillation process that was essentially used by the United States Industrial Chemical Company in producing the first viable material dried by this process.

In a jacketed, agitated still pot, 25 gal. of a concentrated suspension of the biological material was mixed with 75 gal. of a suitable solvent. The still was placed under vacuum so that an absolute pressure of 135 mm. of Hg was maintained. The solvent employed was *n*-butyl acetate and operating conditions were based upon this selection. Steam was supplied to the jacket of the vessel in order to raise the temperature of the dispersion to the boiling point. Vapors which contained a fixed percentage of water and butyl acetate were condensed in a water-

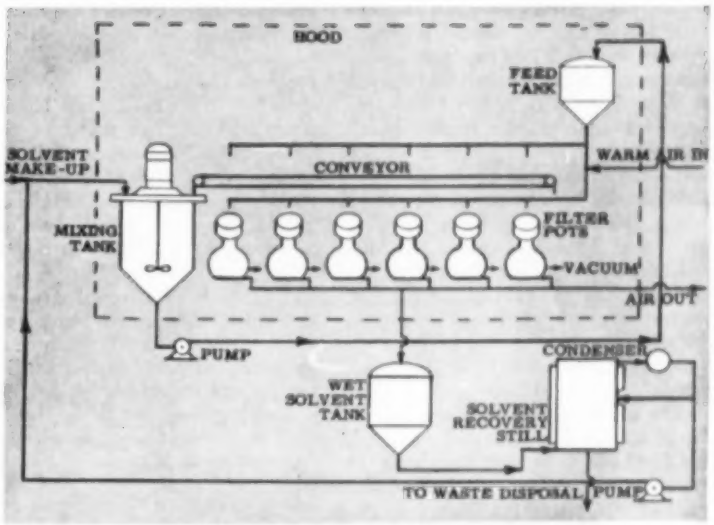
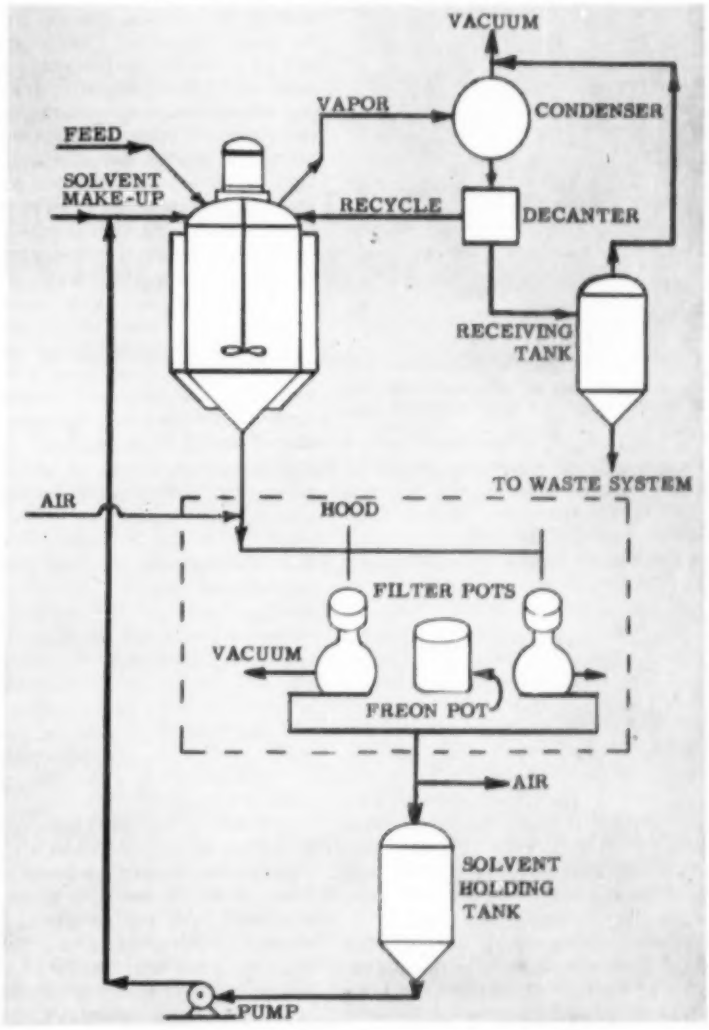


Fig. 1. Schematic flow diagram, solvent extraction process.

Fig. 3. Schematic flow diagram, azeotropic process.



cooled heat exchanger. The condensate flowed into a decanter where it quickly separated into two layers. The top layer of butyl acetate was returned to the still pot as recycle and the water layer was collected in a receiving tank from which it was passed to the waste disposal system.

When the temperature of the vapors above the still reached that of pure solvent at process pressures, the distillation was complete. Filtration was accomplished by gravity feeding the warm slurry of dehydrated product in butyl acetate to a battery of four, 12-in. diam. filter pots in a laboratory hood.

The filtration time was about 2 hr. Butyl acetate filtrate passed through a manifold to a 100-gal. holding tank for reuse and the filtrate was pumped back

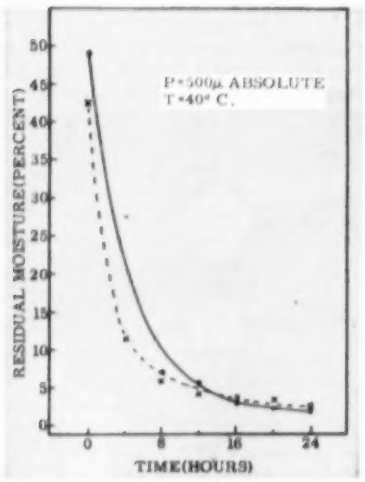


Fig. 2. Drying rate of acetone-wet filter cake of *bacillus subtilis var. niger* in vacuum oven.

to the still pot as needed for subsequent batches. Warm, dry air was used to evaporate the residual butyl acetate from the filter cake.

Experimental work in the laboratory at Fort Detrick showed that butyl acetate was difficult to remove from the filter cake by air drying. A process improvement was initiated whereby each filter cake, immediately after the butyl acetate filtration, was slurried for about 1 min. in ½ gal. of cold Freon-11. The Freon slurry was filtered and the more volatile Freon was removed by air drying at room temperature for 10 min. The air rate used was 35 cu.ft./(min.)(filter pot). Azeotropically dried filter cake was subsequently handled in the same manner as the acetone dried material.

Table 2 shows sample data accumulated from drying runs in the laboratory by both the solvent and the azeotropic processes. Samples of the same batch of feed stock were used for drying by both processes. The data seem to indicate that both processes yield recoveries of viable spores in excess of 100%. This phenomenon can be explained by the fact that the concentrated feed stock has a tendency to clump. The standard bacteriological technique of plate counting is employed, and each colony grown on the plates may represent either one spore or a clump of spores. During processing, agitation in solvents partially deagglomerates the spores; consequently, upon plating, there are more single spores and smaller clumps than in the feed samples. A true indication of process recovery can be achieved only upon the application of biological techniques that allow counting of individual spores.

Comparison of Processes—Extraction, Distillation

Both processes, as described, are fairly competitive as to operating costs. The higher solvent costs for the extraction process are balanced by the increased cost of air used to remove solvent from the azeotropically dried cake. If Freon or any other low boiling solvent wash is compatible with the material being dried, then the azeotropic process has a cost advantage. It should be noted that for the processes described, the types of equipment required are similar. The still, condenser, and receiver required for acetone recovery are integral to the azeotropic process. Both processes described were based on the production of an equal quantity of product per unit time. More runs were required by the azeotropic method described since the drying equipment was rather small. The azeotropic process can be readily scaled up but certain postdrying limitations precluded the use of larger equipment in the pilot plant. It might be added also that both processes may be made continuous with not too much difficulty. The characteristics of the material described are such that, by adjusting the degree of agitation in the azeotropic still and the feed rate, the dehydrated material will settle to the bottom of the still from where it may be continuously withdrawn. Several continuous or semicontinuous extraction procedures are possible.

It is well to note here, however, that in dealing with viable materials, there are time-temperature relationships that influence the compatability of the solvents used with the substances being processed. Nevertheless, it is believed that the novel dehydration of viable, biological materials by the application of processes utilizing organic chemical solvents and featuring the retention of viability in the product, has been demonstrated.

Table 1.—Water Removal from Aqueous Suspension of Spores of *Bacillus Subtilis Var. Niger* in Four-stage Acetone Extraction Process

Stage No.	Water removed from 250 g. sample of concentrated suspension, g.	Per cent of total based on total water removal, per cent
	RUN 1	
1	146.0	79.4
2	23.4	12.7
3	10.0	5.4
4	4.6	2.5
	RUN 2	
1	112.0	76.5
2	23.5	16.1
3	7.4	5.0
4	3.5	2.4

Acknowledgment

The authors wish to express their appreciation to the personnel at Fort Detrick for bacteriological laboratory support and for critical review of this article.

Literature Cited

1. Levin, Ezra and R. K. Finn, *Chem. Eng. Progr.*, **51**, p. 223 (1955).

Presented at A.I.Ch.E. meeting, Chicago, Illinois.

Table 2.—Results of Drying Aqueous Suspensions of *Bacillus Subtilis Var. Niger* by Solvent Extraction and Azeotropic Distillation in Laboratory Equipment

Viable spores in feed /g. (× 10⁹)	Dry solids in feed, per cent	Viable spores in product/g. (× 10⁹)	Residual moisture, per cent
	Solvent (acetone) process		
50	21.1	479	3.4
		404	1.0
		570	1.0
288	26.6	4608	1.0
		4447	1.0
		4102	1.4
398	27.0	5244	1.3
		4592	2.9
		4539	1.0
	Azeotropic (butyl acetate) process		
50	22.0	225	1.4
		354	3.8
		757	2.2
288	26.6	7836	2.2
		8323	1.0
		14,012	1.0
398	27.0	12,030	1.0
		—	1.0
		2930	1.0

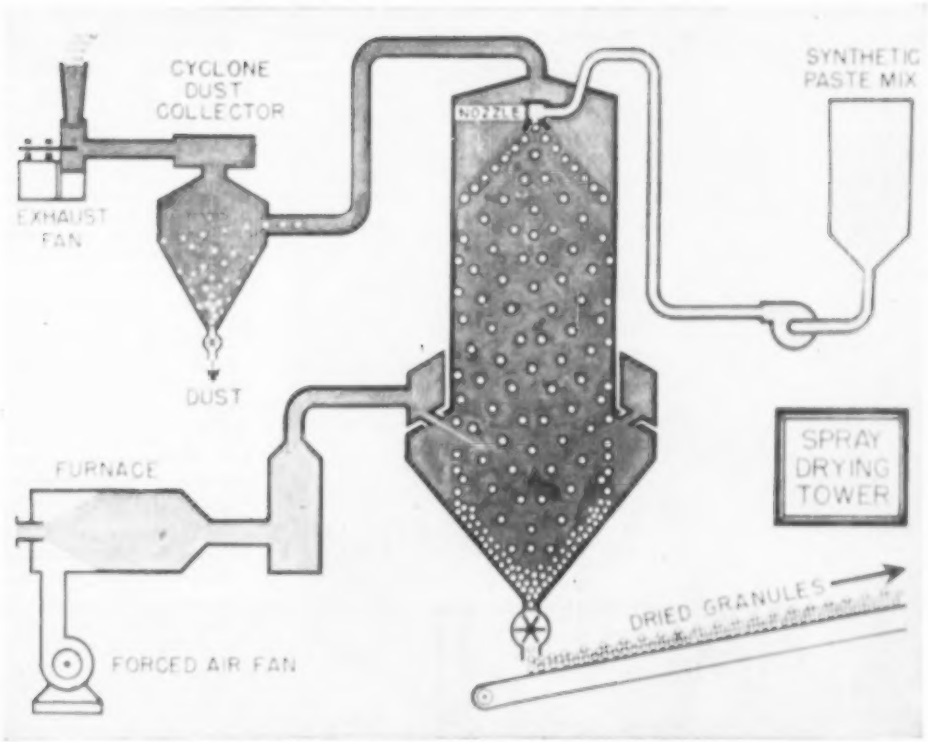


Fig. 1. Simplified sketch for a countercurrent flow in a spray-drying tower.

fundamentals of
SPRAY-DRYING DETERGENTS

J. H. Chaloud, J. B. Martin, and J. S. Baker | Procter & Gamble Company, Cincinnati, Ohio

How a logical study and application of basic principles to the existing information on spray drying can lead to an understanding of its mechanism and serve as an intelligent guide to the extension of this technique.

The popular application of chemical engineering principles to industry is the development, the piloting, the design, and finally the on-stream operation of a new process. This is as it should be, for the real payoff is in new products and new processes. However, there are other interesting and profitable uses of the fundamentals of chemical engineering which are frequently overlooked, but which can be found in those old, well-established processes which are the actual foundations of many of today's industries.

In almost every industry there are at least several operations or processes which have become standard practice long before any detailed technical study has been made. Often these operations, built on years of art and experience, are vital to a company's interest and activity. Usually a proposal to make an exacting and thorough study of such an operation is met with little enthusiasm. After all, the technical know-how built through experience is quite correct and the operation is undoubtedly profitable, hence the question arises why spend a great deal of time and money just to obtain masses of scientific data. An analogy noted here is spray drying in the detergent industry.

Approximately thirty years ago, the first commercial spray-dried soap product was made. Since that time such soaps and synthetic detergent powders have grown to the place where they completely dominate the home-laundry market. The published information on spray drying has been limited to heat- and mass-transfer studies on simple systems and these data have been of only limited help in the application of spray drying to complex slurries in the detergent industry. As a result, this 30-yr. period has seen the knowledge and techniques of spray drying of detergents grow into a highly developed and specialized art, rather than a well-organized science.

Obviously, there is no point in using a classical chemical engineering approach to developing, designing, and pilot planting for such a well-appointed operation as spray drying. It is fair to assume however that a scientific approach would be profitable for

it would be a rare coincidence indeed if this operation had grown and evolved into a stable optimum state. Therefore, some system should lend itself to this situation. After all, the principles of fluid flow, mass transfer, heat transfer, evaporation, and other unit operations are fundamental and are easily applied to what is well known about spray drying.

Spray-drying Process

Perhaps a brief description of the process would be in order at this point. Basically a spray-drying tower is a thermally balanced heat-exchange operation in which atomization is used to produce a large surface for heat and mass transfer. Figure 1 is a simplified sketch for a countercurrent flow in a spray-drying tower, but a concurrent and mixed flow is also used in this industry.

The tower itself is a cylinder with a conical bottom. Hot air enters through a plenum chamber at the top of the cone and leaves by a central take-off at the top of the tower. The detergent slurry is atomized by pressure nozzles at the top of the tower and falls by gravity through the tower, leaving as dried material through the cone.

So far the operation sounds simple. However, things inside are not so simple.

In the first place, a range of droplet sizes is obtained from the nozzle. By virtue of their size range, these droplets differ in such important respects as specific surface, length of diffusion path, and rate of fall through the tower. Furthermore, the air does not simply rise through the tower. The air is given a helical motion, or swirl, which establishes a somewhat stable flow pattern and generates turbulence on a small scale. This rotational motion exhibits some rather large differences in the vertical and tangential veocities throughout the width of the tower, as shown in Figure 2. The tangential velocity shows a drop toward zero at both the axis and the wall. Note should be made also of the high vertical velocity at the axis. These velocity curves show the presence of a core of air with high rotational velocity rising through the center of the tower with both the tangential and vertical velocities decreasing towards the outside of the tower owing to the effect of the shear.

One effect of this air pattern is to throw the droplets of drying granules out toward the walls of the tower. Another important effect is that the fluid shear gives good thermal mixing of the air within the tower. The temperature gradient through the tower plotted in Figure 3 shows this point. The actual measured temperatures within the tower are much lower than the inlet air temperature due to excellent mixing in the base of the tower.

Returning to the study of spray drying as an operation, one must remember that, actually, the physical characteristics of the finished product are a real consideration in spray-drying detergents. Indeed, it is important to know that certain parameters must of necessity direct this operation. One such limiting factor is that the bulk density of detergents must be considered as fixed by the carton. A definite weight of product must be placed in a box of a certain size.

The moisture content of the granules may also be considered as fixed, because in a predetermined composition, a change in percentage of moisture will change the amount of useful detergent packed in the carton. It is true there is some flexibility here in that the formula can be adjusted so as to provide for the optimum moisture content, but once fixed, it is then committed to that moisture level during operation. Control of either density or moisture content alone is easy; it is the interaction of density, moisture, and particle size that is complicated.

As directed by the following primary objectives, a theoretical treatment of spray drying is developed which combines chemical engineering fundamentals with practical spray-drying experience.

1. Control of product moisture
2. Control of bulk density
3. Control of finished product particle size
4. Accomplishment of maximum tower capacity for economic reasons.

A three-dimensional plot is first established using the primary objectives of bulk density, product moisture, and tower capacity as the axes. By use of different sizes or number of pressure nozzles and changes in composition of the feed, there is some independent control of particle size. On the assumption of a spray-drying tower operating under constant conditions, including rate, the product has a certain bulk density and moisture, and this density and moisture cannot change as long as the other conditions do not change. By increasing the pumping rate of stock to the tower yet maintaining the other conditions constant, say, by increasing the number of nozzles in order to keep the spraying pressure the same, an increase in the total granule surface which can lose moisture in the tower occurs. Therefore, the result is more total evaporation, causing more evaporative cooling of the air, and a lowering of the average tower temperature. A lowering of the tower temperature causes less evaporation and less steam puffing for each individual particle or granule, and therefore density increases. Again, although more total evaporation is the result, there is less evaporation from a single particle (since temperature is lower) and therefore the product moisture increases.

This same type of reasoning is used throughout the development of this theory. It may seem tortuous and complicated, but it does follow a definite pattern. First, the direct effects of a change are considered, and then the secondary effects resulting from a change in tower temperature are de-

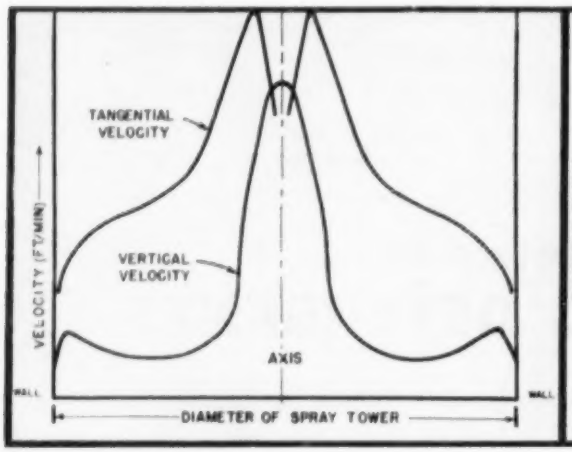


Fig. 2. Vertical and tangential air velocities in a spray tower.

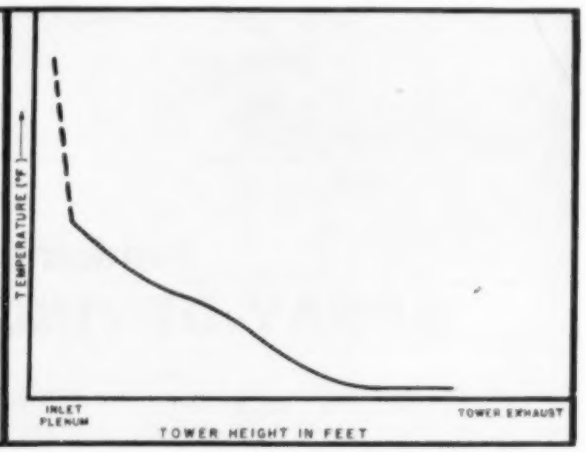


Fig. 3. Vertical temperature gradient through a countercurrent tower.

veloped. The average tower temperature, a dependent variable, cannot be held constant in this reasoning.

Figure 4 is just such a deduced curve and is obviously approximate, but the absolute shape of the curve is not too important as long as the curve is continuous and has a positive slope. This curve is called an "operating line" in space, and so long as other conditions of the tower and the feed remain fixed, the tower must operate along this curve.

Variables

The technique used so far, allows for only one independent variable. To make this system of any practical use, it is necessary to consider some of the other variables. Taking a slice through the three-dimensional plot at a constant rate plane results in a two-dimensional bulk density-moisture plot. Now it is possible to deduce the change in density and moisture, at a constant rate, resulting from a change in other variables, such as particle size, air temperature, air throughput, tower height, tower turbulence, and feed moisture.

DROP SIZE

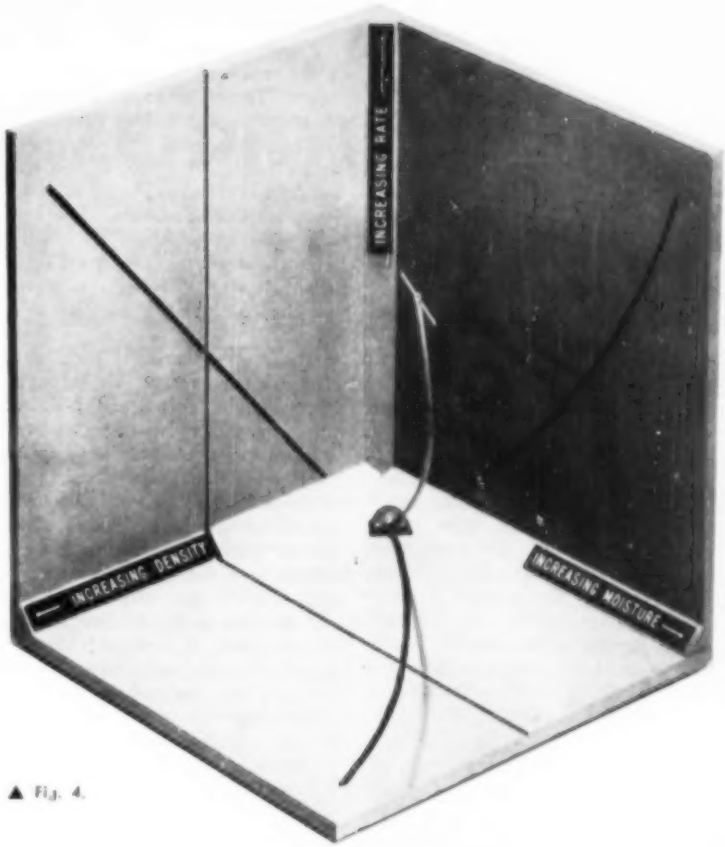
To start this procedure, drop size is considered first. The same total amount of material in fewer and larger drops means less surface area. Therefore, there is less evaporation and higher product moisture. Less over-all evaporation means a higher tower temperature. This means more evaporation per granule and, therefore, more puffing and a lower density. Thus, an increase in drop size is represented by an arrow in the direction of higher moisture and lower density. Since the relative magnitudes of these two effects are not known, the arrow is simply placed in its proper quadrant. This procedure is followed all the way.

AIR TEMPERATURE

Increasing the inlet air temperature means more evaporation due to higher temperature differential and hence lower product moisture. The higher temperature also means more puffing due to steam formation, hence a lower density. Therefore, an arrow of increasing temperature is placed in the direction of lower moisture and lower density.

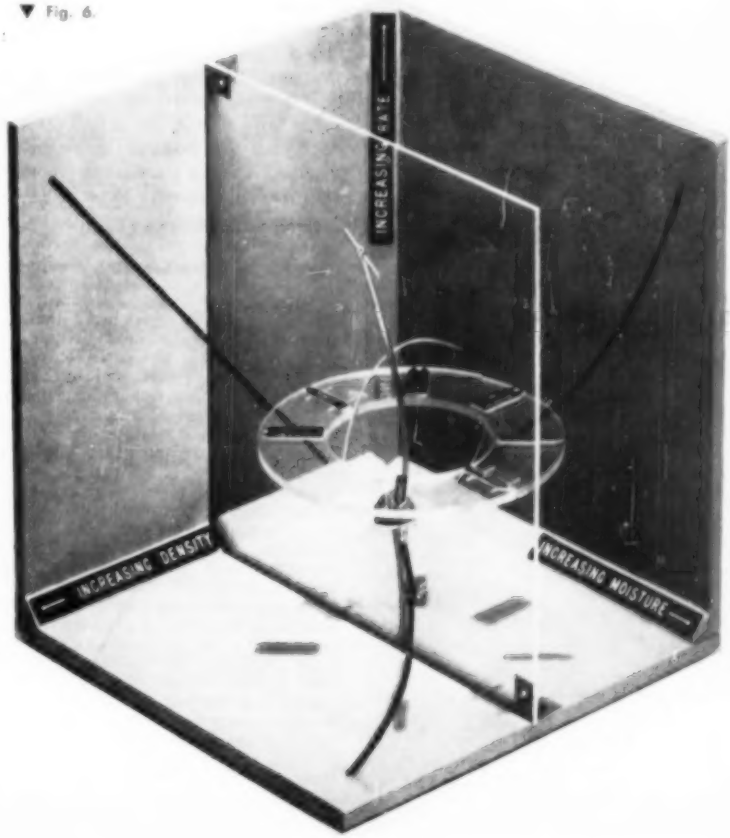
AIR THROUGHPUT

The effect of increasing the air throughput means simply more air at the same inlet temperature. This means a higher exhaust temperature, therefore more total evaporation, a lower product moisture, and more steam puffing causing a lower density.



▲ Fig. 4.

▼ Fig. 6.



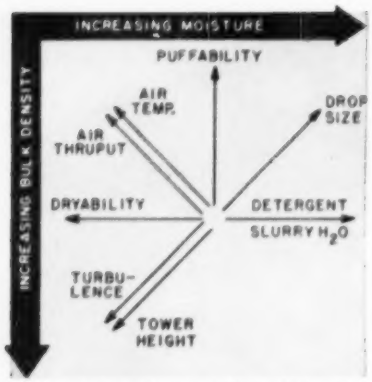


Fig. 5. Independent variables which affect density, moisture, and tower capacity.

TOWER HEIGHT

The effect of increasing tower height is to make for a longer retention time in the tower, therefore, more drying, lower moisture. More drying, however, lowers the average air temperature, thereby decreasing the puffing and increasing the density. Therefore, an arrow for increasing tower height is placed in the direction of lower moisture and higher density.

TURBULENCE

Turbulence has rather a complex action. Turbulence is increased by increasing the swirl in the tower, that is, the rotational motion. This, of course, means a higher air to particle relative velocity and an increase in heat-transfer coefficients, giving more rapid drying, and hence a lower moisture product. More drying means a lower air temperature, therefore, less steam puffing and a higher density. Also, the increase in turbulence increases air mixing, lowering the air temperatures, and again giving less puffing and higher density; therefore, the arrow is placed in the direction of lower moisture and higher density.

FEED MOISTURE

So far this discussion has been limited to tower operating variables. What does it mean to increase the feed moisture? Simply from a heat balance it means a higher product moisture. However, there may be a change in density also. A high particle moisture means a lower boiling point giving more puffing, and that results in a lower density. However, a higher particle moisture means more evaporation, therefore, lower temperature, which tends towards higher density. Since there is no way of knowing which situation would predominate as a general rule, the arrow is placed in the direction of showing no change in density, and it must be realized that it may swing a little bit to one side or the other.

"DRYABILITY," "PUFFABILITY"

Finally, there are two other variables which should be placed on this figure. These factors are properties of the feed and they are named with coined words: the first is dryability, or the ability of a mix to lose water; by definition it is placed to indicate lower product moisture. The second is puffability, which is the ability of a mix to steam-puff; by definition this means having no effect on moisture but simply causing a decrease in density.

These other variables then of drop size, air temperature, air throughput, tower height, turbulence, feed moisture, dryability, and puffability as shown in Figure 5 are the independent variables which are considered to affect density, moisture, and tower capacity. As stated previously, the exact directions and magnitudes of the vectors are not known, but they are placed in the best estimated direction and without a quantitative indication of magnitude. It is possible, of course, to determine by experiment the direction and magnitude of these effects for a particular feed in a particular tower, but the specific results usually do not justify doing the work.

These effects are deduced at a constant but unspecified rate. The same pattern results at any other rate by this process of deduction and placement of the arrows. While it is true that the amount and the direction of shift may be slightly different at different rates, the over-all effect is that a change in one of these variables shifts the position of the curve in space. Figure 6 shows the placement of these other variables about the operating line so that now this "model" method of presenting the theoretical treatment of spray drying is complete.

Can this curve be applied to a practical case? It must be remembered that bulk density is a fixed primary requirement for a packaged product. This fixed density may be represented by a plane. Therefore, when operating along this line, the operation must be at the point of intersection of the operating line with this constant density plane. Thus, when any variable operates to shift the curve the rate must change to return to the plane of proper density. For example, if a decrease is made in the tower height, which moves the curve in this direction, opposite the direction of increasing tower height, the product is light and wet. Therefore, increasing the throughput rate brings the product to the plane of proper density but also with a further increase in product moisture. If this increase in product moisture can be tolerated in the product, it should be noted that shortening the tower results in *increased* rate—a point not apparent without this model.

Thus, a curve has been developed that shows the relationships among rate, density, and moisture for a constant set of conditions and also shows that changing the tower or feed stock variables operates to shift this curve. This curve can be and is being used to analyze the effects of proposed changes in tower or formulas, to indicate possible corrective measures, and to guide the planning of future experimental work.

One might wonder if this is really a practical theory, especially since it is not based on equations and numbers. It most assuredly is. It was first put to test by submitting it to a number of development engineers with many years' experience in spray drying. In each instance, experience was consistent with theory. The curve was then used to recommend a change in tower operation and to predict a result that was not obvious, and was even contrary to what superficial reasoning would lead one to expect. After a deductive reasoning of this theory, it can be shown that a reduction in tower air turbulence, which means a loss in heat- and mass-transfer efficiencies, should still increase tower productive capacity just as is achieved with a reduction in tower height. This was tried in both pilot plant and factory towers with the expected increase in tower rates.

As is evident, this is not a complete or an exact study of the science of spray drying, nor is it intended that it should be. The point that should be made, however, is that the fundamentals of chemical engineering can be applied to the present knowledge of a going operation for the purpose of reaching a more precise understanding of the process, and in so doing, lead the way to a more intelligent application of this process. This procedure has been applied successfully to spray drying, and certain changes have been indicated and made for increasing production capacities. Also, this study has outlined the means for predicting the results that can be expected with changes in present products or with completely new materials. The three-dimensional model developed in this study is only a convenient method of presenting all the information obtained in one simple illustration.

Concluding Comment

There is nothing novel or radically different about the method used in this study. Rather is it a logical, systematic review of the information already known about spray drying and the application of the fundamental principles of chemical engineering unit operations to this previous information. It is apparent that this same method could be applied to other old, well-established processes in other industries.

Presented at A.I.Ch.E. meeting, Chicago, Illinois.

Improved heat transfer system for*

FREEZE-DRYING

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Those engaged in bulk freeze-drying of sensitive materials will find in this article practical methods for obtaining shorter cycles and more uniform temperature conditions.

The method of freeze-drying or sublimation from the frozen state has been found to be an excellent means of preserving thermolabile materials.

This article deals with the collection of physical data required for the design of an improved heat-transfer system for batch freeze-drying of heat-sensitive materials to a moisture content of less than 1% at optimal rate. The study was conducted during freeze-drying of biological suspensions in a pellet form. Data demonstrating the effect of the following factors were required:

a) intensity of the heat source
b) optimal layer depth, that is, tray loading
c) total drying time (which is controlling on over-all cycle time)
d) mode of heat transfer.

Conditions fixed at the outset were:

a) vacuum, peak and terminal in microns of mercury abs. p.
b) condenser temperature, peak and terminal
c) maximum initial and terminal material temperature
d) required residual moisture content.

The optimum combination of treatment variables should result in delivering a product with a final moisture content of minimum value, in this case 1% or less. Proper sizing of larger scale equipment with respect to drying surface area would be possible when the above-listed values became known.

Material

The material to be dried was frozen in Freon-113 in the form of pellets slightly oval in shape, of approximately 4 mm. diam. These were free-flowing at −30° C. and relatively infrangible under normal handling conditions. Suspended solids content of the liquid before freezing was approximately 10% with a density of 1.05 g./ml. The freezing point was −5° C. The bulk density of the frozen pellets was experimentally determined at 0.49 g./cc.

The vacuum oven method was used for moisture determination after standardization against the vacuum P_2O_5 method to constant weight. This established that the empirical condition of time and temperature used for serum (*1*) applied to this new and different composition.

Equipment

A standard commercial F. J. Stokes Corporation freeze dryer Model No. 2005-FFX4 (Figure 1) consisted essentially of a drying chamber enclosed within a dehumidified booth. It was provided with:

(1) Five hollow heat-transfer platens through which a thermostatically controlled electrically heated fluid was circulated. A single stage refrigeration system was also provided for chilling of this fluid.
(2) Two hollow condenser platens which were cooled by a three-stage refrigeration system.
(3) A vacuum system consisting of an oil-booster-type vapor pump backed up by a Stokes mechanical, rotary-vacuum oil-sealed pump.
(4) A Stokes-McLeod gauge equipped with a chemical vapor trap, which measured the total chamber pressure.
(5) A Bristol 12-point thermocouple recording system.
(6) Several Weston dial thermometers.
(7) The required trays for product loading.
(8) A walk-in dehumidified hood for sampling and collection of dehydrated product (Figure 2).

Experimental Results

Preliminary tests were run in 20 × 20 cm. stainless steel trays at a layer depth of 16 mm.

In an effort to reduce the cycle time, the complete tray inside and outside bottom, and both upper and lower dryer platen surfaces were painted black. Cycle time was thereby reduced from approximately 22 hr. to approximately 16 hr. and 30 min. (run 119-65). When an aluminum tray was used, a comparable cycle time was obtained although results were more uniform with blackened steel trays than with unblackened aluminum trays. Trays were suspended between the platens as an additional aid in obtaining greater uniformity of drying. This eliminated all contact conductance from platen to tray. By being limited almost entirely to radiant transfer in this way, it was possible to increase the intensity of the heat source without increasing the temperature of the material layer. Blackening the surfaces and suspending the trays resulted in more uniform distribution and reception of heat which resulted in greater uniformity of temperature conditions across the layer. This increase in uniformity is shown to have the net effect of shortening the drying cycle. Graphical analyses, Figures 3, 4, and

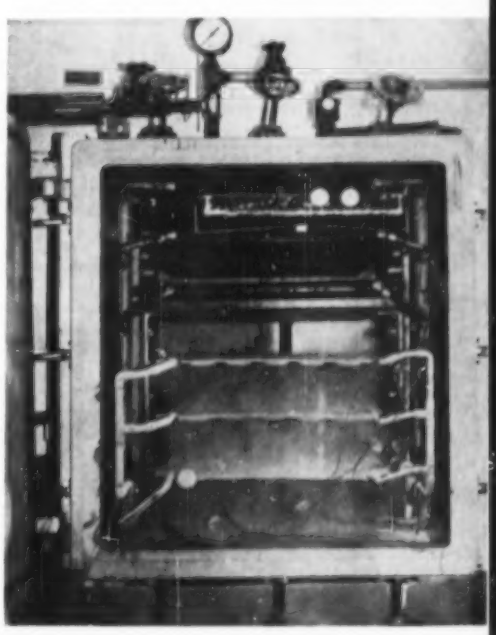


Fig. 1. Interior of freeze drying cabinet, showing tray position.

* This work was supported in part by a contract with the Chemical Corps, Fort Detrick.

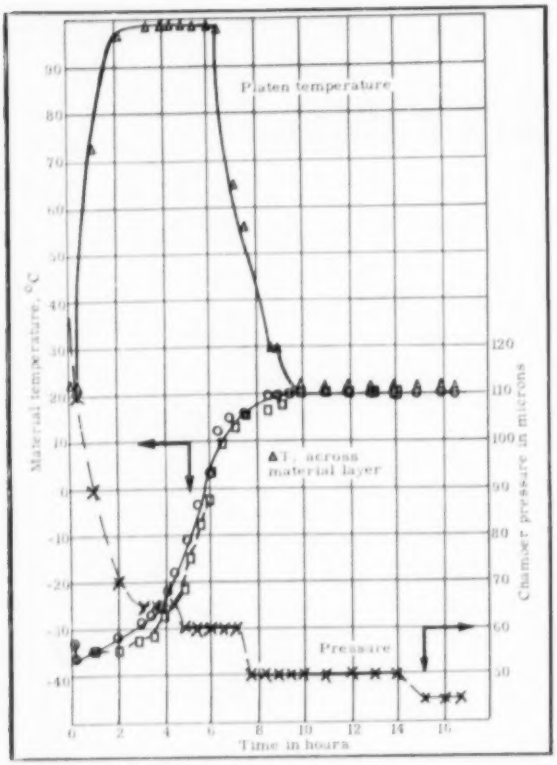


Fig. 4. Graphical analysis: shelf temperature, material temperature, and chamber pressure. Materials: 16 mm. layer of pellets in blackened 20 × 20 cm. S. S. tray suspended (M).

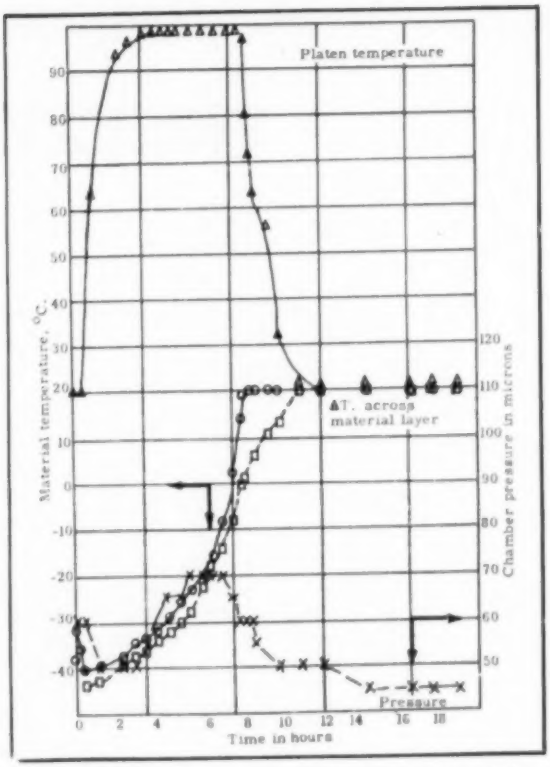


Fig. 5. Graphical analysis: shelf temperature, material temperature, and chamber pressure. Materials: 16 mm. layer of pellets in Al tray, 20 × 20 cm., suspended (M).

Table 2.—Temperature vs. Residual Moisture

At Vapor Pressure = 1μ

Temperature °C.	% Water
20	1.2
40	0.6
90	0.3

Fig. 6. (Note: all temperatures measured with dial thermometers).

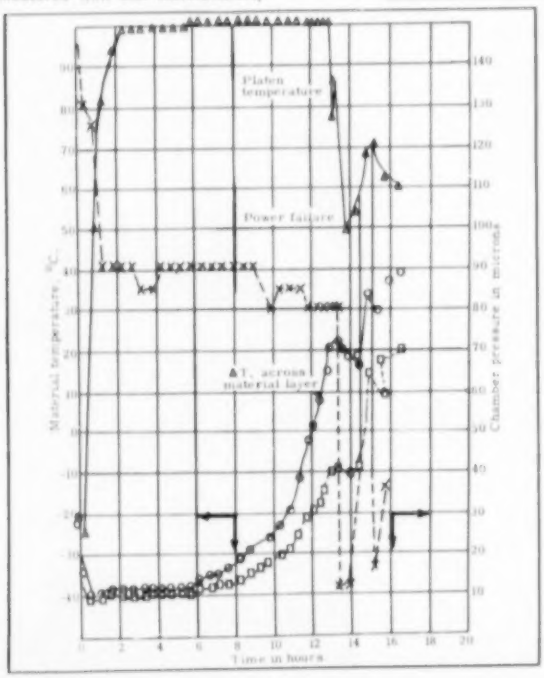
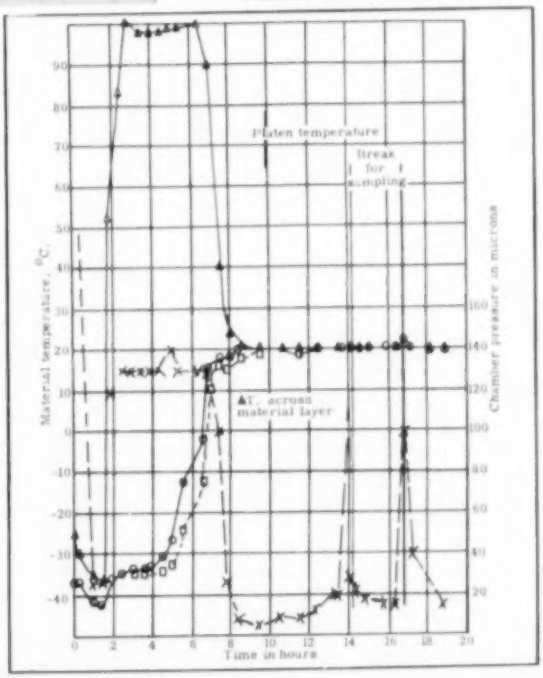


Fig. 7. (Note: all temperatures measured with dial thermometers).



5, illustrate these points. It should be noted how the measured temperature differences across the layer are reduced in the blackened stainless steel and aluminum trays (Figures 4 and 5) as opposed to the wide temperature range (Figure 3) where just an ordinary stainless steel tray was used.

When this work was repeated in a larger tray, it was found that cycle time and conditions obtained by using a 30 × 90 cm. tray of 1½ mm. thick aluminum did not coincide with those obtained with an 20 × 20 cm. aluminum tray (Figures 6 and 5). Figure 5 shows stage 1 of only 10-hr. duration, while Figure 6 indicates a period for stage 1 greater than 16 hr. Blackening of the tray bottom decreased the cycle time but did not approach earlier results of drying in the 20-cm. tray. Run No. 31-8 which resulted in a stage 1 time of 16 hr. caused grave doubts as to the validity of scale-up factors for tray size. It was therefore decided to conduct all future tests with a 45-cm. wide tray which was the width then recommended for scale up.

Table 1.—Effect of Tray Size, Construction, and Finish on Length of First Stage of Drying at a Layer Depth of 16 mm. of Frozen SM Pellets

Type of tray	Replicates	Length of first stage-hr.
A. 20 × 20 cm. stainless steel, bottom thickness 1½ mm.	4	15:25
B. 20 × 20 cm. stainless steel, bottom thickness 1½ mm. Black bottom and black shelves	3	10:40
C. 30 × 90 cm. aluminum, bottom thickness 1½ mm.	1	18+
D. 30 × 90 cm. aluminum, blackened bottom thickness 1½ mm.	4	14
E. 45 × 90 cm. aluminum, blackened bottom thickness 6 mm.	4	13:45
F. 45 × 90 cm. aluminum, blackened ribbed bottom, thickness 6 mm.	18	9:45

A flat, black-painted, aluminum, 45-cm. wide tray (Figure 8) was tested for drying-cycle time with a reduction to approximately 12 hr. for stage 1 using this tray.

A similar tray was fitted with 45 × 90 cm. × 16 mm. high ribs spaced 2.5 cm. on centers along its axis (Figure 8) in order to provide more metal surface for conduction and radiation of heat energy to the material. Figure 7 indicates a stage 1-cycle time of about 9 to 10 hr., illustrating the increased drying rate obtained with this design. Table 1 shows a comparison between this tray and others of varying design and construction which were tested.

A tray embodying the ribbed aluminum design feature was finally selected since it was shown that the contents dried at the fastest rate in this type of tray and exhibited the greatest degree of uniformity of heat input across the layer.

Output Related to Significant Variables

A series of comparative tests was carried out utilizing maximum process material temperatures selected not to exceed +20 and +40° C.* Heating intensity was controlled by material temperature but did not exceed +100° C. Chamber pressure was maintained below 30μ during stage 1 of drying and at 1μ during the balancing-out period. Layer depth treatment was varied from 4 to 24 mm.

Residual moisture contents were analyzed for different treatments during stage 2 of the drying period (balancing out) at time intervals of 3, 7,

* In two comparative series of runs, maximum material temperature of 20° C. was exceeded. These are indicated, however, because they received like treatment and are therefore comparable.

OPERATING PROCEDURE

(1) The drying chamber is cooled to −30 to −40° C.

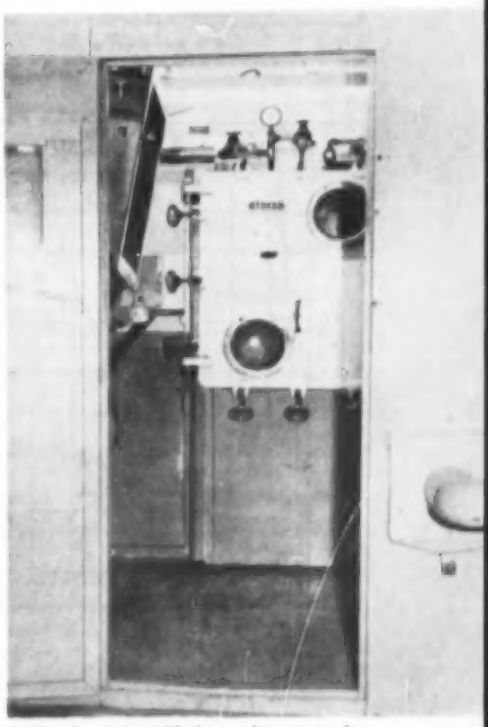
(2) The product, frozen in pellet form at −30° C., is filled into trays which are suspended in the drying chamber.

(3) The drying chamber is evacuated and the platen temperature raised to a properly chosen maximum value. Initially, the heat is utilized for the evaporation of the moisture in the product. During the process the frozen product retains its initial temperature (−30° C. or less).

(4) The condenser platens condense the water vapor in the form of ice.

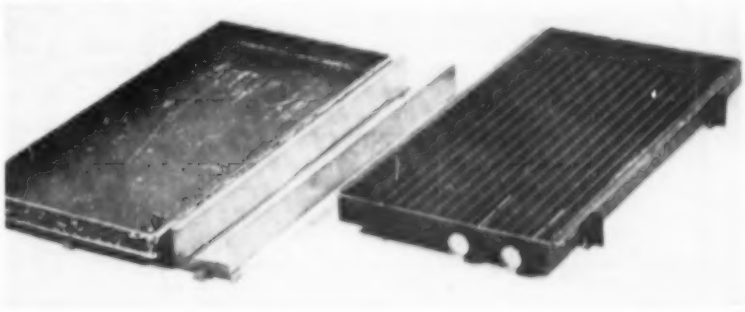
(5) As complete sublimation of ice is achieved, the temperature product rises. This represents maximum dehydration as far as is possible at this stage of the cycle. When it reaches a properly chosen "control temperature," the heat input is reduced by allowing the platen temperature to drop. The product temperature is allowed to rise to a predetermined "balancing temperature" equal to the final temperature of the platen. The product is retained at this temperature over the so-called "balancing-out period."

For the purpose of clarity it should be stated that a typical freeze-drying cycle is defined as having a first stage for ice sublimation and a second stage or balancing-out period for final desiccation of the dry solids. The first stage is that period of time when the temperature of the heat source exceeds the temperature of the material. The second stage is the period when the heat source temperature and material temperature are the same, plus or minus one degree. The residual moisture content is reduced to a minimum during the balancing-out period.



▲ Fig. 7. Dehumidified sampling room for Stokes cabinet.

▼ Fig. 8. 36-in. flat and ribbed trays.



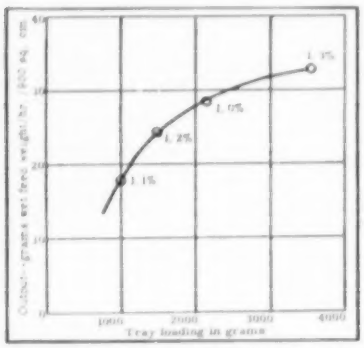
10, 15, and 25 hr. Figure 9 illustrates the equilibrium terminal moisture removal curve for material dried at 20 and 40° C.

Table 2 illustrates the per cent equilibrium terminal moisture contents remaining in the products at a vapor pressure of 1μ or less and at terminal product temperatures of +20, +40, and +90° C. These data were obtained by continuing exposure to these several conditions until constant moisture content was reached.

Data included in Figure 10 and Figure 11 summarize the trend produced by changing the controllable variables. From these data it has been possible to select the optimal variable conditions and the most efficient tray design.

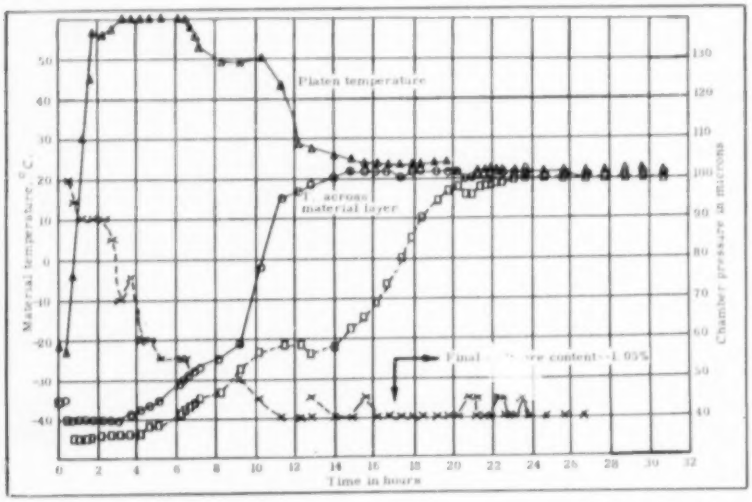
Figure 10 illustrates the nonlinear increase in output (expressed as wet weight feed) with greater tray loading for similar heating cycles in flat black trays. This factor limits increase in loading as a means for improving capacity. Percentage residual moisture obtained at approximately the same point is indicated since the hourly rate of output per unit area of tray surface is naturally determined by the time needed to dry the batch to the desired residual moisture content under the particular conditions of heating and tray loading used.

The relative effect on output of heating temperature as well as tray loading is shown in Figure 11. Black trays of two designs were used, flat, ribbed. Data are summarized from runs made with three different heat input cycles. The nonlinear increase in output with greater layer depth, previously shown in Figure 10 at one temperature condition for flat trays, also is indicated in Figure 11 and appears as the vertical line. This is an illustration of the relative effectiveness of heating intensity, layer depth, and tray design.



▲ Fig. 10. Output vs. tray loading (flat). Per cent residual moisture indicated. 100 to 20° C. heating. 45 × 90 cm. trays, 4 mm. diam. pellets.

Fig. 3. Graphical analysis: shelf temperature, material temperature, and chamber pressure. Materials: 16 mm. layer. Pellet tray: 20 × 20 ▼ cm. S. S.



Conclusions

As compared with the flat-tray design, ribbed-tray design with a given loading yields greater output at any usable temperature condition tested.

In addition, ribbed design compared with flat design shows more rapid increase in output as heating intensity is increased. To compensate for volume occupied by the ribs, greater layer thickness was utilized to maintain comparable tray loading based on drying platen area. Actual metallic tray heating surface to which pellets were exposed in ribbed trays was approximately 215% greater than in flat trays.

The 100 to 40° C. heat range with black ribbed trays produced best output with acceptable final content of residual moisture.

Acknowledgment

Grateful appreciation is extended to the following personnel of Fort Detrick, The Army Chemical Center, and the F. J. Stokes Corporation for their support and assistance: T. R. Dashiell, W. Hamilton, J. Murphy, S. Tease, and C. E. Wilkes.

Literature Cited

1. Flosdorf, E. W., and Webster, *J. Biological Chem.*, **121**, p. 353 (1937).

Presented at A.I.Ch.E. meeting, Baltimore, Maryland.

▼ Fig. 9.

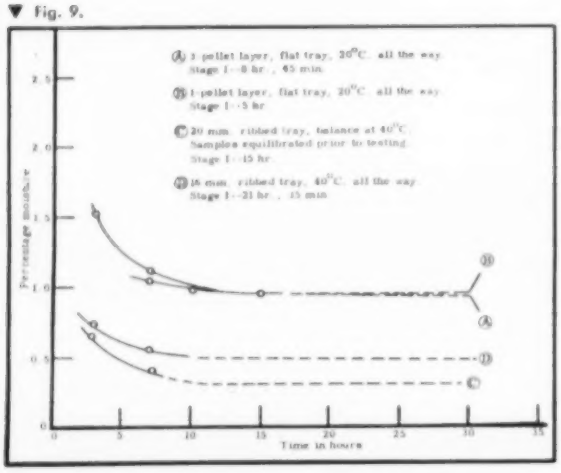
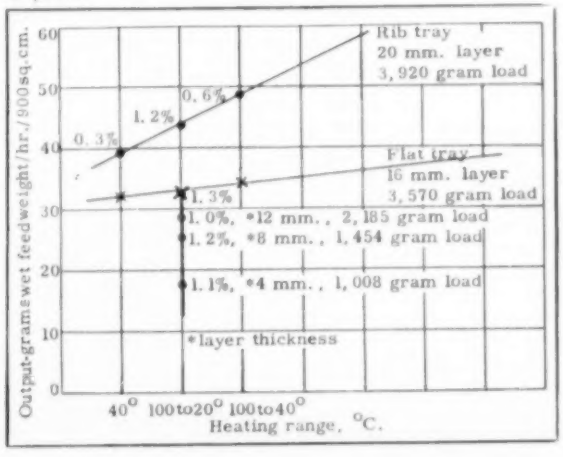

Ⓐ 3-pellet layer, flat tray, 20°C. all the way. Stage I—8 hr., 45 min.
Ⓑ 1-pellet layer, flat tray, 20°C. all the way. Stage I—5 hr.
Ⓒ 20 mm. ribbed tray, balance at 40°C. Samples equilibrated prior to testing. Stage I—15 hr.
Ⓓ 16 mm. ribbed tray, 40°C. all the way. Stage I—21 hr., 15 min.
Percentage moisture
Time in hours

Fig. 11. Output vs. heating temperature and tray loading. Per cent residual moisture indicated. 45 × 90 cm. black trays, 4 mm. diam. ▼ pellets.



sorption processes

granular processes—ion exchange

W. A. Selke

Peter J. Schweitzer, Inc.
Lee, Massachusetts

Ion exchange resins of many types have become available commercially since 1947. Cation and anion exchange types include strong and weak acids and bases. The resins can be obtained in roughly spherical particles of size down to 325 mesh if desired. The size of the micropores is variable, depending on the degree of cross-linking of the resin matrix. The resins are now quite durable chemically and mechanically. Process evaluation experiments are simple to perform. Data from beds 1-in. diam. can be used for the design of units of 11-ft. diam. The equipment is simple in design and construction. For these reasons, ion exchange resins have found a wide variety of uses. The most important commercial application is water treatment, the most refined is the separation of rare earth salts.

These conditions are favorable to the continued growth of ion exchange, especially for the treatment of dilute solutions, ones containing 1,000 p.p.m. or less. Furthermore, as the breadth of application increases and as larger units are designed, there is need for more extensive chemical engineering.

Two areas where engineering advances can be expected are the development of continuous ion exchange equipment and the adoption of methods for the design of fixed beds based on the principles of unit operations. Continuous operation could be of particular value when ion exchange is employed as part of a chemical process. In a well-engineered continuous contactor, the productive capacity of the resin can be greatly increased above that obtained in fixed beds with cycle time of 2 to 24 hr.

Results of research and development on ion exchange with granular materials can be of value in the study of other sorption processes. Mechanical techniques for continuous contacting of fluids and solids can be applied broadly and the mathematics of fixed bed ion exchange can be applied equally well to adsorption.

PART 2

Part 1 ("Adsorption, Dialysis, and Ion Exchange—An Introduction"; and "Granular Processes—Adsorption") appeared in the November issue.

Prospects for large-scale application of ion exchange in chemical processing were made brighter by a recent report by C. W. Hancher (*1*) on progress made at Oak Ridge National Laboratory.

The apparatus described is the Higgins contactor, which is semicontinuous in that the resin bed moves in steps periodically. The operation is automatic and is essentially a continuous system. In the paper, co-authored by S. H. Jury (*1*), it was stated that in many schemes for continuous countercurrent ion exchange, hydraulic problems have been anticipated with scale-up, but these are mastered in the Oak Ridge design.

Operation of the contactor is shown in Figure 1. Since the flows of feed and regenerating solutions are downward through the respective beds, the rates can be extremely high.

In September, 1956, a 12-in. diam. pilot scale contactor was used at Grand Junction, Colorado, to pick up uranium salts from an ore extract. The uranium was stripped from the resin by a solution of ammonium nitrate and nitric acid. As many as 12 tons of ore/day was processed in this pilot unit. The concentration of the uranium in the product stream reached 12 g./liter of U_3O_8. Conditions and results of this test are listed in Table 1.

A test loop, 3-ft. diam., was built to measure the amount of water required to cause the resin bed to circulate and to determine the pressure drop in the system (Figure 2).

Significant progress has been made in improving the efficiency of the transporting of the resin through the loop. It was shown that the use of a "hydraulic oscillator" greatly reduces the amount of water necessary for pulsing the resin. This oscillator is essentially a valveless pump, with adjustable stroking rate. It is shown in Figure 3. It was most effective when producing pressure variations with a frequency of 28 cycles/min. Under optimum conditions, the volume of resin moved by pulses of water was as much as 90% of the volume of water used for pulsing.

Advances have been made in the design of the valves and the instruments necessary for full-scale operation of the contactor. Outstanding is the "particulate flowrator" by which the amount of resin passing through a portion of the system was actually counted by a photocell system.

Hancher and Jury (*1*) have undertaken to develop theoretical expressions for the flow of mixtures of resin and water in a continuous loop. By using a concept of "resin pressure," they were able to predict closely the performance of the hydraulic rams constituting their circulating system. Their equations will be valuable in designing new contactors.

The Higgins mat shows interesting potentialities for treating a wide variety of process streams in which dilute solutions are to be concentrated.

Although the ion exchange of tomorrow may be conducted in continuous systems, the bulk of the interest today is in the use of cyclical fixed beds. Considerable aid is given to those undertaking process design of such beds by a recent report by N. Frisch and F. McGarvey (*2*). In this report techniques were described by which bed performance can be estimated by application of material balances and equilibrium relationships alone. Their method is applicable to the estimation of column capacity as a function of regeneration level and for the calculation of leakage through beds.

The authors showed that for most industrial cases an equilibrium expression of the following form

$$K = \left(\frac{1 - X_A}{X_A}\right)\left(\frac{y_A}{1 - y_A}\right) \quad (1)$$

fits most systems adequately, where y_A and X_A are the equivalent fractions of the ion species A in liquid and resin phases, respectively. This expression represents the mass action relationship or the Donnan Membrane mechanism for exchange of ions of equal valence, but it can be used as an approximation where the exchange is between ions of unlike valence. This equilibrium relationship is plotted in Figure 4.

Data on equilibrium for many cation systems were given as functions of the degree of cross-linking of the resin.

Frisch and McGarvey (*2*) have derived expressions for leakage from beds in terms of this equilibrium parameter. Equations are then derived for the performance of a bed of resin based solely on material balances and equilibrium relationships. Examples are given of the use of these equations, such as for the regeneration of a quaternary ammonium ion exchange resin (Figure 5), and for the leakage of sodium ions in hydrogen cycle operation, Figure 6. The agreement between experimental data and the equilibrium theory was best with the low-regeneration levels which are important in industrial applications.

Design methods for fixed beds have for some time been under evaluation by T. Vermeulen and N. K. Hiester. In a recent report (*3*) this work was further advanced by the inclusion of techniques for handling the full range of possible rate mechanisms. Chemical reaction, external diffusion, internal or pore diffusion, and longitudinal diffusion or mixing—all can be treated.

Rate relationships were cast in the form of heights of transfer or reaction units. The authors made use of data from the literature and correlated the number of transfer units with the Péclet group, which is expressed by $(dU/\epsilon/6D)(1-\epsilon)$, where d is the particle diameter, U is the fluid velocity, D the diffusivity, and ϵ the void fraction. This is shown in Figure 7. A mechanism parameter was defined and used to correct for internal diffusion resistance.

The resulting predictions of breakthrough curves for fixed beds were presented on a generalized plot (see Figure 8).

The calculation of the number of transfer units from fixed-bed data is possible by use of Figure 9. An alternative procedure is to use a cross-plot, such as shown in Figure 10. Vermeulen and Hiester (*3*) pointed out the manner in which the slope of a breakthrough curve at the point of 50% leakage characterizes the curve. In cases where pore diffusion was an important resistance, this was only approximate, but the use of the mid-point slope in analyzing data still was convenient.

The authors demonstrated the utility of their results for calculating such aspects of bed performance as resin

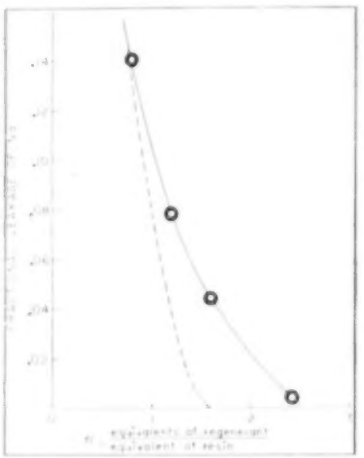


Fig. 6. Comparison of actual and calculated sodium leakage in hydrogen cycle operation.

Table 1.—Summary of Grand Junction Test II

CONDITIONS:

Resin—Permutit SK (10 to 20 mesh)
Feed rate—7 gal./min. (580 gal./(sq.ft.)(hr.)
Ore consumption—12 ton/day (80 tons total)
Pulse frequency—5 min.$^{-1}$
Slip water ratio—4.2 : 1.0
Material balance—104%
Flow balance—101%

Stream	Flow Rate (gal./min.)	Uranium concentration g. U_3O_8/liter	Remarks
Feed	7.00	0.98	
Feed wash	0.90	.....	
Strip	0.45	.....	1 M NH_4NO_3, 0.1 M HNO_3
Strip wash	0.57	.....	
Acid wash	0.08	.....	0.5 M H_2SO_4
Waste	8.20	0.002	
Slip water	0.30	.....	
Product	0.60	12.10	
Resin	0.08	65.00	

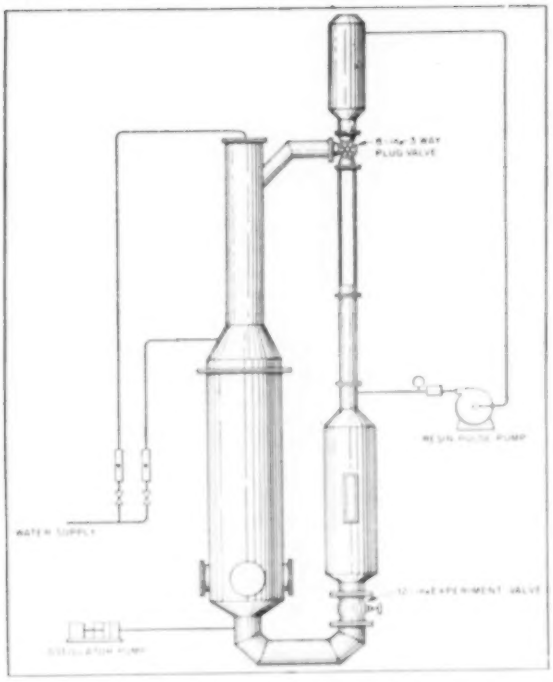


Fig. 2. Diagram of 36-in. resin test loop.

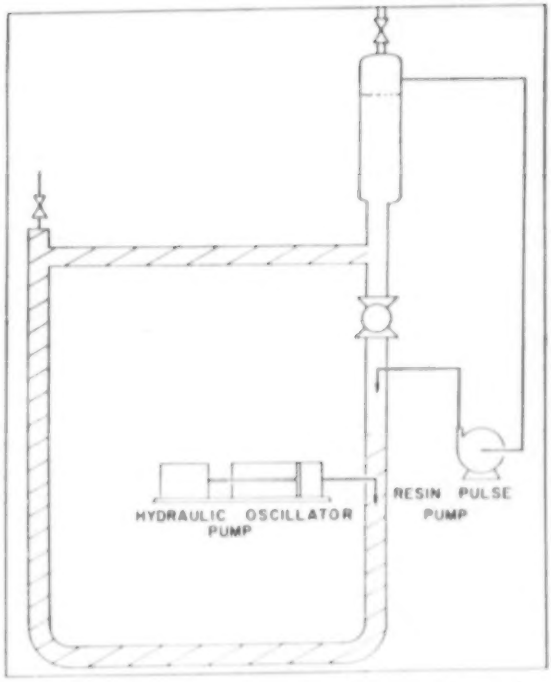


Fig. 3. Experimental equipment for the hydraulic oscillator study.

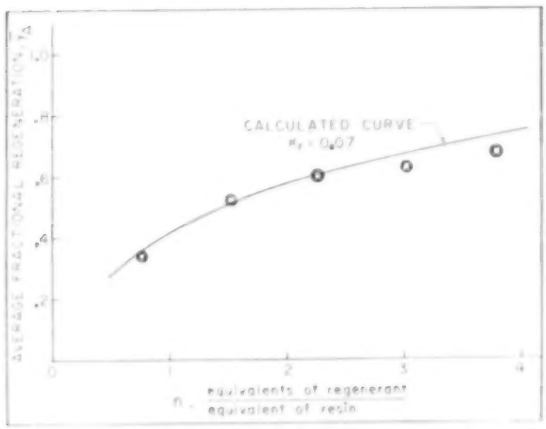


Fig. 5. Comparison of actual and calculated average fractional regeneration of quaternary ammonium ion exchange resin.

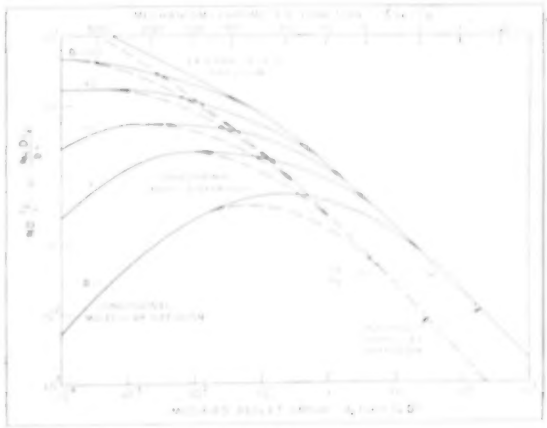


Fig. 7.

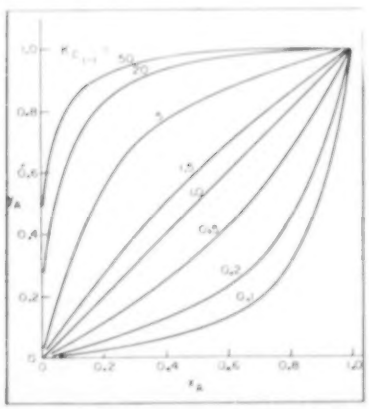


Fig. 4. Equilibrium plot, univalent-univalent exchange.

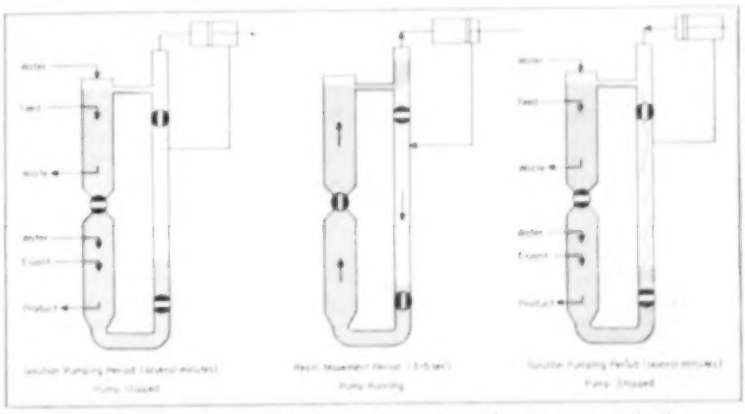


Fig. 1. Schematic diagram of Higgins continuous ion exchange contactor, showing mechanism of countercurrent solid-liquid flow.

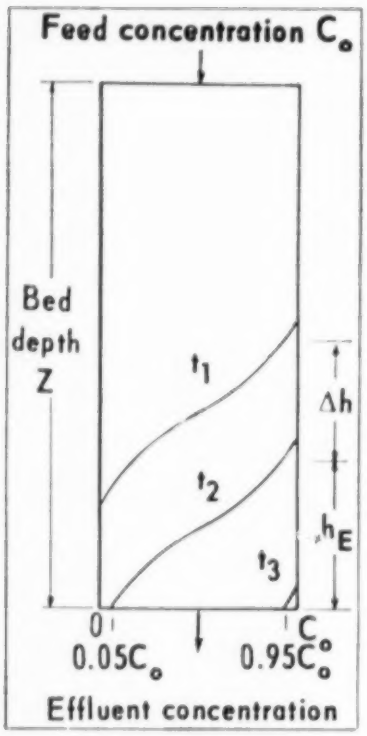


Fig. 11. Hypothetical solution concentration gradients in a fixed bed—favorable equilibria.

utilization, regenerant efficiency, and bed leakage. The inclusion of modifications of the calculation for beds which are partially presaturated removes one of the major barriers in applying this work to the design of industrial ion exchange units.

Coming this Spring

A.I.Ch.E. Symposium Series Vol. 53, No. 22 on

SORPTION PROCESSES

A complete collection of the papers which provided the basis for the accompanying article will be published soon in paper binding and will be available at nominal cost.

Literature references cited by author Selke in the accompanying article correspond to chapters in the coming volume as follows:

1. Jury, S. H., and C. W. Hancher, "Semicontinuous - Countercurrent Apparatus for Contacting Granular Solids and Solution."

2. Frisch, N. W., and F. H. McGarvey, "Application for Ion Exchange Equilibrium Relationships to Process Design."

3. Vermeulen, Theodore, and N. K. Hiester, "Kinetic Relationships for Ion-Exchange Processes."

4. Powell, J. E., and F. H. Spedding, "Basic Principles Involved in the Macro-Separation of Adjacent Rare Earths From Each Other by Means of Ion Exchange."

5. Moison, R. L., and H. A. O'Hern, Jr., "Ion Exchange Kinetics."

The difficulty in developing exact mathematical formulas for conditions of practical interest in the operation of ion exchange columns has led to the further investigation of the "exchange zone" method of correlation (*5*). The portion of the bed considered the exchange zone is that in which the feed concentration is reduced from 95% of the influent value to 5%. This is shown schematically in Figure 11. This approach was proposed by Michaels in 1952. It is based on the fact that for exchange with favorable equilibrium, the exchange takes place in a band of nearly constant length which moves down through the bed as it is being saturated. The exchange zone is a moving frame of reference which can be regarded mathematically as a continuous system in which resin and liquid flow countercurrent to each other. The assumption is made that a steady-state process is taking place within this moving zone.

A new method for calculation of the height of the exchange zone, h_E, from c/c_o 0.05 to 0.95 is

$$h_E = \frac{V_E C_0}{A(Q_T \epsilon C_0)}$$

where V_E = solution volume to displace the exchange zone from the bed, A = cross-sectional area of bed, C_0 = feed concentration, Q_T = resin capacity, and ϵ = fraction voids. The rate at which the exchange zone moved down through the bed is

$$u_R = \frac{u_L C_0}{Q_T + \epsilon C_0}$$

where u_L = solution velocity. Equations are derived for calculating the number and height of the liquid-film transfer units in the exchange zone.

The system studied experimentally was the exchange of 0.01 and 0.1 normal NaCl with hydrogen-form Dowex-50 resin. This equilibrium is somewhat favorable, as is shown in Figure 12. Analysis of many data showed an effect of the ratio of bed depth to the particle diameter on the height of the transfer unit. The final correlation is shown in Figure 13. The bed depth was seen to influence to some degree the values of height of transfer unit. This was explained as an indication of longitudinal mixing.

The effect of resistance to diffusion in the resin on the height of a transfer unit was determined by plotting the height of a transfer unit based on the liquid film vs. the concentration for a given flow rate. This is shown in Figure 14. Each plot for a given flow rate was linear, as was expected. However, the resulting values of the solid phase resistance depended on the 0.3-0.4 power of the flow rate. It is suggested that a greater proportion of the surface of the particles was available to the solution as the flow rate is increased.

A study was made also of the reverse exchange, hydrochloric acid with the sodium resin, for which the equilibrium is unfavorable. The results are shown in Figure 15 compared with those predicted from the theoretical equation of Goldstein, which is based on equilibrium operation. While the results are in fair agreement, the differences between the curves indicate the existence of diffusional resistance.

One of the outstanding achievements in the use of ion exchange for chemical processing has been the separation of adjacent rare earths. J. E. Powell and F. H. Spedding (*4*) have recently explained important advances in the techniques for achieving this separation.

In this technique, the ionic mixture is eluted through the column by a chelating agent. It proceeds down the column in a tight band. Cupric ion, sent down ahead of the band, prevents the band from spreading as it proceeds down the column. This technique of separation differs from simple chromatographic separations in that the bands of solutes do not spread apart as they move down the column, the authors stated, but the solutes separate by displacement within the single moving band. This is shown schematically in Figure 16. In practice, the column referred to actually consists of a bank of vessels in series in order to secure a bed of adequate total length.

The theoretical plate concept was employed in deriving an expression for the degree of separation to be expected from the passage through a given length of column. The separation stems from difference in the stability constants of the different rare-earth chelates. Hence, the separation factor used is based on these constants, rather than on difference in affinity in ion exchange.

Ammonium ethylenediaminetetraacetate and ammonium *N*-hydroxyethylethylenediaminetriacetate were found to be extremely effective eluting agents for separating rare earths. By the use of them 1,000 lb. batches of zenotime or gadolinite were separated into sharp fractions of better than 99.9% purity. The results were interpreted by means of the separation theory, and showed good agreement.

This work demonstrated the feasibility of separating commercial quantities of the rare earths by ion exchange and opens the way to wider industrial exploitation of the properties of these elements.

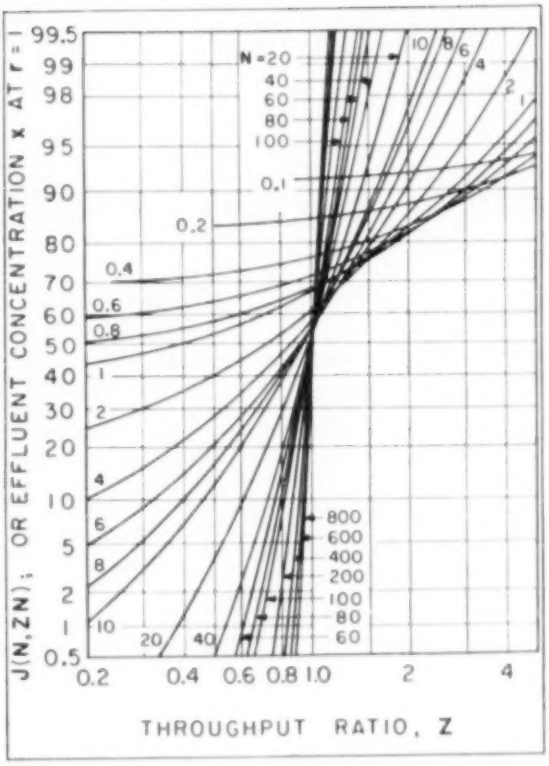


Fig. 9.

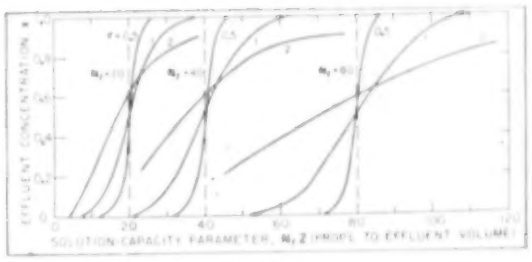


Fig. 8.

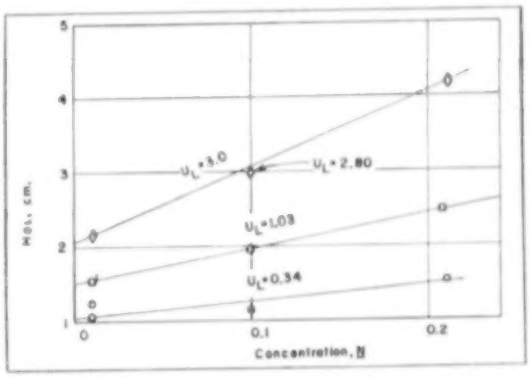


Fig. 14. Effect of feed concentration on the height of a transfer unit

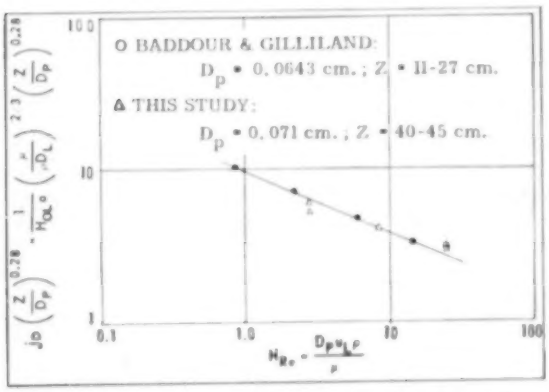


Fig. 13. General correlation of data for the exchange of 0.01 N NaCl with "Dowex" 50 (H^+).

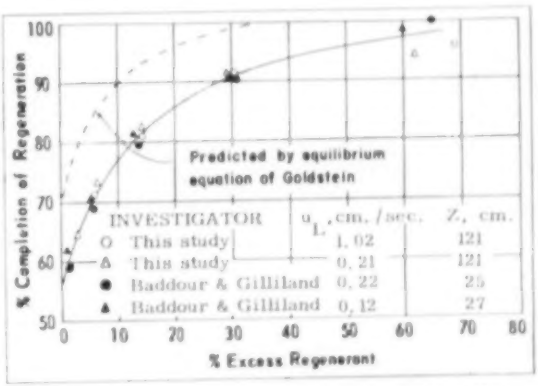

% Completion of Regeneration
% Excess Regenerant
Predicted by equilibrium equation of Goldstein
INVESTIGATOR | u_L, cm./sec. | Z, cm.
O This study | 1.02 | 121
Δ This study | 0.21 | 121
● Baddour & Gilliland | 0.22 | 25
▲ Baddour & Gilliland | 0.12 | 27

Fig. 15. Correlation of regeneration data for 0.1 N HCl and "Dowex" 50 (Na^+).

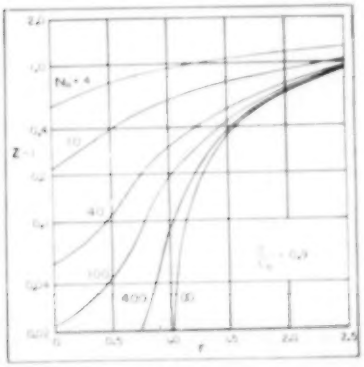


Fig. 10.

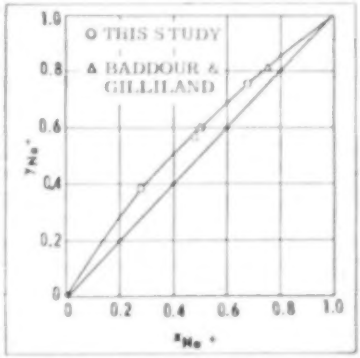


Fig. 12. Equilibrium selectivity data. "Dowex" 50 (H^+) + 0.1 N NaCl.

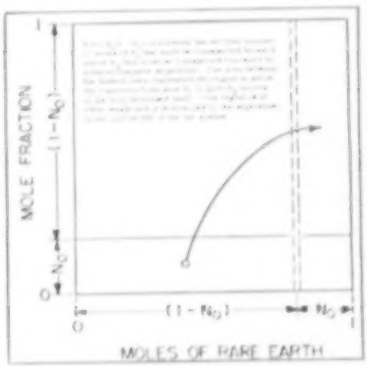


Fig. 16. Model of an adsorbed band demonstrating conditions before and after separation of a mole of binary mixture.

sorption processes

membrane processes —

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Rohm & Haas Company
Philadelphia, Pennsylvania

Industrial application of membrane processes, prior to the resurgence of interest in membranes during the past ten years, had been limited by low mass transfer rates and poor membrane selectivity. The dialytic separation of caustic soda from hemicellulose solutions and the separation of uranium isotopes by gaseous diffusion through multistage barriers were examples of early successful operations based on membrane processes.

Research since 1947 in academic and industrial circles has concentrated on a study of the mechanisms whose additive effects determine the rate of mass transfer across membranes—adsorption and desorption, diffusion down a concentration, an electrical potential, or a hydraulic pressure gradient, electroosmosis—as well as on selectivity characteristics of the membranes. One or more of the listed mechanisms are involved in each the successful applications of membranes to commercial operations; for example, in separation of gases or vapor by passage through plastic membranes, pressure and concentration gradients are responsible for diffusion through the films, by an adsorption-desorption mechanism, while in desalinization of sea water by electrodialysis, concentration gradient diffusion, osmosis, and electroosmosis contribute to the main effect ascribed to electrical gradient diffusion. Ultrafiltration substitutes a pressure gradient for an electrical gradient in the previous example.

While the various types of membranes do not appear to be on the verge of changing radically the areas of application of existing separation processes, they do have many unusual fundamental properties which may find industrial application in the not too distant future.

A membrane process in which a pressure gradient is chiefly responsible for mass transfer across a barrier has recently been reported by Karl Kammermeyer (*1*). The mechanisms of mass transfer across the barriers could be described as an adsorption-desorption mechanism.

Microporous membranes enable separation of gases due to difference in the diffusion rates of gases in passing through the micropores. For best results the diameter of the micropores must be less than the mean free path of the gas, perhaps as small as 200 A. For gases such as H_2, He, N_2, O_2, and CO_2, the permeability (the flow rate divided by the pressure drop through the membrane) is independent of pressure and temperature in the range 20-100 lb./sq.in. gauge and 77-122° F. Membranes of silicone rubber have recently been found to have 10-50 times the permeability of other plastics.

An adsorbent membrane may be a plug of finely divided carbon, a piece of microporous glass, or a plastic sheet, whose permeability is dependent on the pressure and temperature. Figure 1 shows the permeability of methylbromide through polyethylene and Figure 2 shows the permeability of ammonia through porous glass. In each case, the permeability increases rapidly as the saturation condition is approached. A tentative procedure has been developed for analyzing total flow into the flow along the adsorbent surface and through the pores of the adsorbent.

Procedures have been developed for calculating the number of stages required in a cascade system employing multiple barriers and reflux. Experimental data on the separation of hydrogen from nitrogen can be correlated satisfactorily by the Weller-Steiner equation, while data obtained on the separation of propane from carbon dioxide cannot. The preferential selectivity of the membrane for propane is attributed to the flow in the adsorbed phase since both materials have the same molecular weight.

The separation of benzene from ethanol in a feed of the azeotropic composition (presented graphically in Figure 3) shows improved separation at lower temperatures. Best results at 100° C. gave a permeate composition of 0.52 mole fraction for a reject of 0.42 mole fraction, when one half of the feed, 0.48 mole fraction, was permeated through the membrane.

—ion exchange

Dialysis, or the separation of colloidal from crystalloidal material by diffusion of the latter through a semipermeable barrier, depends largely on the presence of a concentration gradient to cause mass transfer across a membrane. The largest commercial application of dialysis is in the manufacture of rayon, where caustic soda is recovered from a solution containing hemicellulose. A view of a commercial Brosites dialyzer is shown in Figure 4, and an exploded view of the frames and membranes in Figure 5. Countercurrent flow of water and hemicellulose solution on either side of the membrane is employed.

In an analysis by J. A. Lane and J. W. Riggle (*2*) the over-all rate of mass transfer, U_o, through the membrane is assumed to depend on the mass transfer through the liquid films, U_L, and the membrane, U_M, as follows:

$$\frac{1}{U_o} = \frac{1}{U_L} + \frac{1}{U_M} \text{ and } U_M = 60\frac{DFV'}{hz}$$

where

D is the diffusivity in free solution

F is the Faxen hindrance factor

V' is the fraction voids in the swollen membrane

h is the tortuosity of the micropores in the membrane

z is the swollen membrane thickness

hz is the equivalent path length of the micropores through the capillary.

For dilute solutions,

$$W = U_o A \Delta C_{lm}$$

where

W is the amount dialyzed, g./min.

A is the membrane area, sq. cm., and

ΔC_{lm} is the log mean terminal, concentration difference in g./cc.

A more exact equation can be given for concentrated solutions where the solute and solvent diffuse in opposite directions through the membrane.

The transfer rate of a solute through the membrane alone, U_M, can be measured by agitating vigorously the solutions on both sides of a membrane. From the transfer rate of sodium chloride through the membrane, the tortuosity, h, of the micropores can be calculated, assuming the hindrance factor, F, equal to 1. Knowing h, one can calculate the hindrance factor, F, of a large molecule from the measured membrane transfer rate of that large molecule. From F and the estimated diameter of the solute, the micropore diameter can be calculated from the Faxen equation (Figure 6). The measured average tortuosity of commercial parchment paper and cellophane membranes is found to be 3.5.

The separation of inorganic solutes from large molecular weight organic solutes does not appear attractive from a practical viewpoint until the diameter of the latter becomes comparable to the membrane pore diameter. This is illustrated in Figure 7, for sodium sulfate and sucrose.

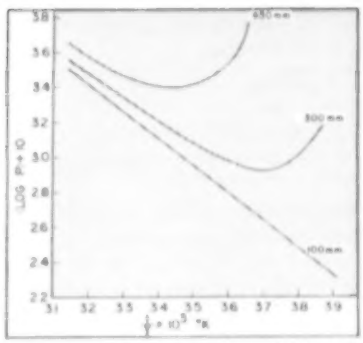


Fig. 1. Permeability curves for methyl bromide through polyethylene. (reported by Sobolev et al).

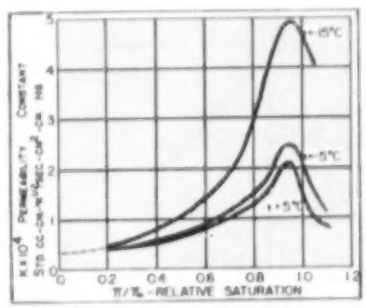
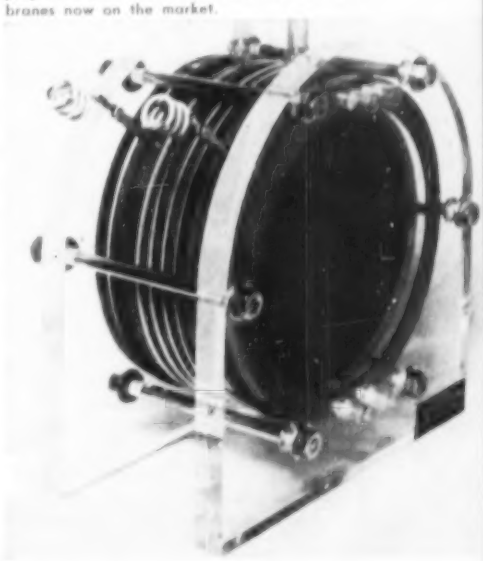


Fig. 2. NH_3 permeability through No. 1 porous glass membrane.

Fig. 4. Electro-dialyser designed to utilize properties of various new ion selective membranes now on the market.



In ultrafiltration, mass transfer is effected largely through application of a pressure gradient across the membrane, with concentration gradients playing a minor role. Originally used to separate colloids from solutions, it has been applied in a study by W. E. Henderson and C. M. Sliepcevich (*3*) to the retention of crystalloidal solutes, such as sucrose, dextrose, and raffinose as measured by ultrafiltration through cellophane membranes.

These studies show retention varying directly with flow rate through the membranes. For sucrose, Figures 8 and 9, the retention was 12 to 25% at a pressure drop of about 50 to 400 lb./sq.in. gauge where retention is defined to be the per cent reduction in the feed solute concentration on passing through the membrane. As expected, the larger the size of the solute, the greater the retention. For the ultrafiltration of dilute solutions at a high rate, the retention appears to depend primarily on the ratio of pore radius to solute molecule radius. Increase in retention with increase in solute concentration, shown in Figure 9, can be attributed to partial blocking of the pores. The retention of mixtures of three sugars is about that predicted from their individual retentions. Practical value of separation by ultrafiltration appears limited by the low flow rates observed, about 2 cm./sec. at a

pressure drop of 300 lb./sq.in. gauge.

Ultrafiltration provides a method for measuring the diameter of the micropores in the membrane by combining the Poiseuille equation for the laminar flow of water in the micropores and the swelling of the membrane in water. The Poiseuille equation in c.g.s. units is:

$$q = \frac{\pi r^4 \Delta P N A}{8 l \mu}$$

and the water content of the membrane is given by

$$w = \pi N r^2 L$$

where

N is the number of micropores of radius r and length L.

Simultaneous solution of these equations gives the micropore radius. For Du Pont No. 300 cellophane, the result, 28 Å diam., is in reasonable agreement with the value of 38 Å reported by J. A. Lane and J. W. Riggle, based on an analysis of diffusional rates through membranes.

A study of ultrafiltration of salt solutions through ion exchange membranes by J. G. McKelvey, Jr., K. S. Spiegler, and M. R. J. Wyllie (*4*) indicates that saline water may be partially desalted by forcing the saline solution through an ion exchange membrane under a pressure great enough to overcome the osmotic pressure, which is about 430 lb./sq.in. gauge for sea water. The exceedingly low permeability of efficient membranes makes the costs of production prohibitive at this time.

A schematic drawing of the action of micropores in ion exchange membranes in filtering out salt is given in Figure 10, showing that the larger the micropores the less the filtering action. The potential shown is the streaming potential arising from the flow of the solution through the membrane, which contains a higher concentration of salt on one side of the membrane than the other. In Figure 11, data are presented on the ultrafiltration of salt solution through an anion exchange membrane Nalfilm-2. The effluent salt concentration is about 50% of the feed for an 0.98 N (5.7%) sodium chloride feed solution, for a flow rate of only about 0.3 cc./(sq.in.)(day), too low to be of practical value in water purification. The salt filtration observed is the best to date and is in accordance with the idea that membranes with the highest charge and smallest micropores, and therefore lowest permeability, give the best desalting. A more practical membrane would require theoretically a high negative value of the ratio of the osmotic to the hydraulic permeability.

In electrodialytic membrane processes, an electrical potential gradient is the dominant force causing mass transfer, with concentration and pressure gradients playing secondary roles. The applications of ion exchange membranes in electrodialysis, as reported by E. A. Mason and W. Juda (*5*) show an increasing diversity and promise.

Ion exchange resin membranes are good conductors of electricity when immersed in solutions placed between

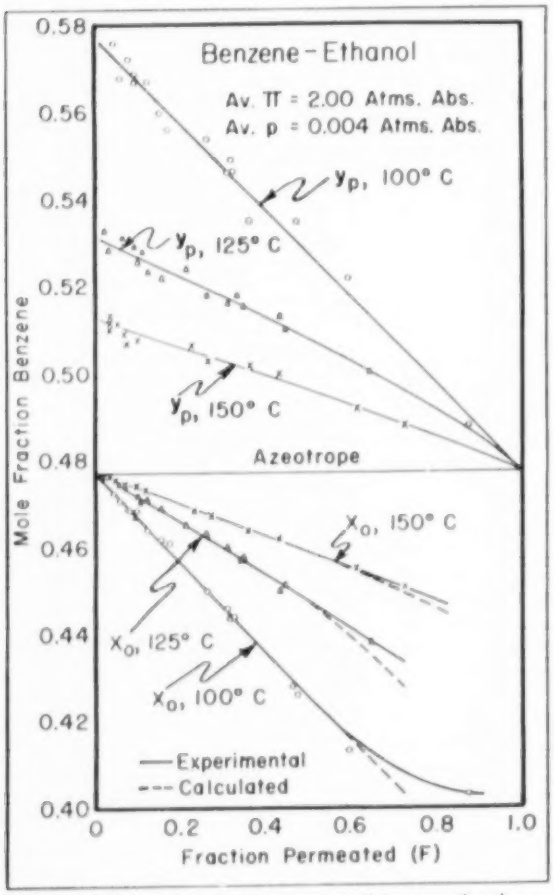


Fig. 3. Super-atmospheric separation of benzene-ethanol.

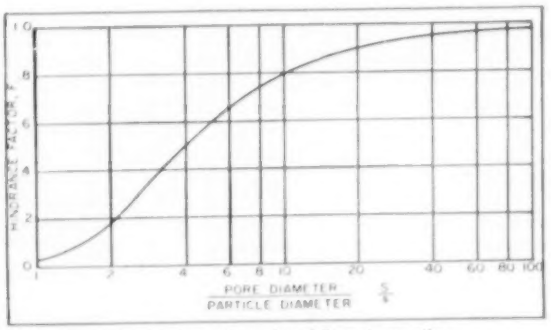


Fig. 6. Convenient plot of Faxen's equation.

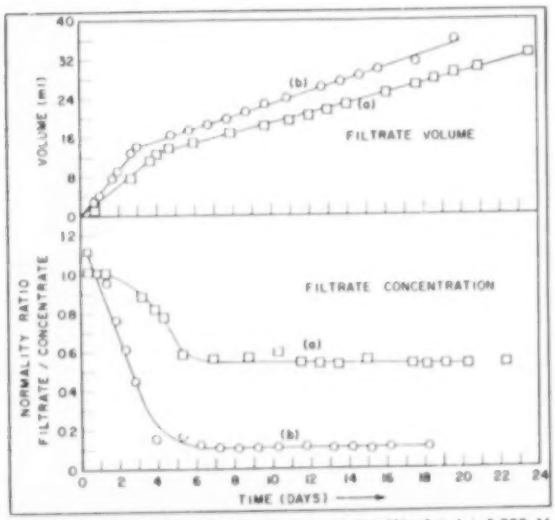


Fig. 11. Permeability and salt filtering of "Nalfilm-2." (a) 0.982 N; (b) 0.0986 N NaCl. 1,000 lb./sq.in.; membrane area = 20.4 sq.cm.

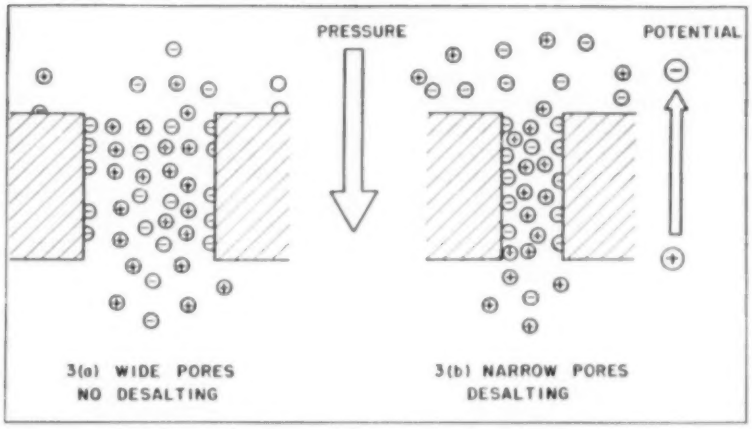


Fig. 10. Salt filtering and streaming potentials for two pore sizes.

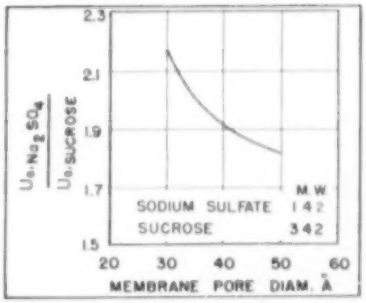


Fig. 7. Dialysis rate vs. pore diameter.

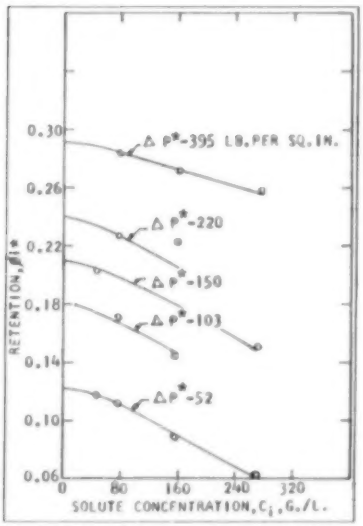


Fig. 8. Effect of concentration on retention at constant pressure. Membrane 18-C; sucrose, 25° C.

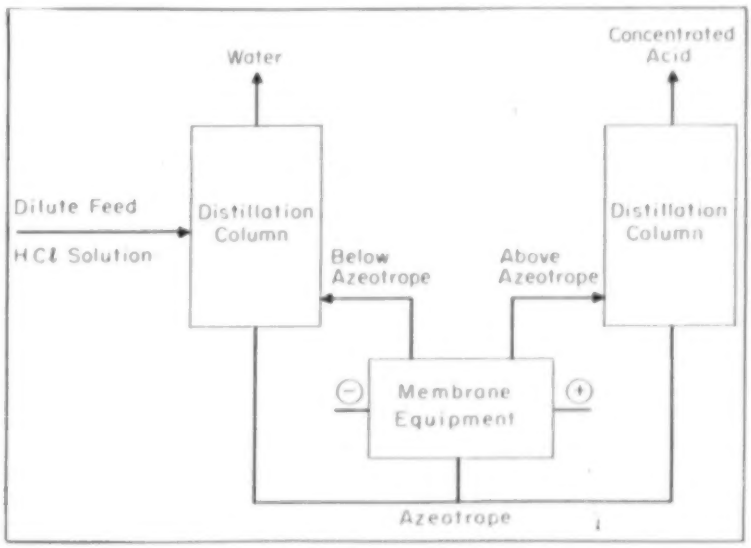


Fig. 13. Application of membranes in distillation.

Fig. 9. Effect of ultrafiltration rate on retention. Membrane 18-C, sucrose, 25° C.

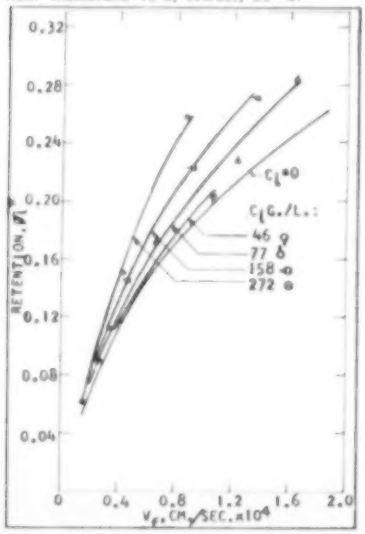
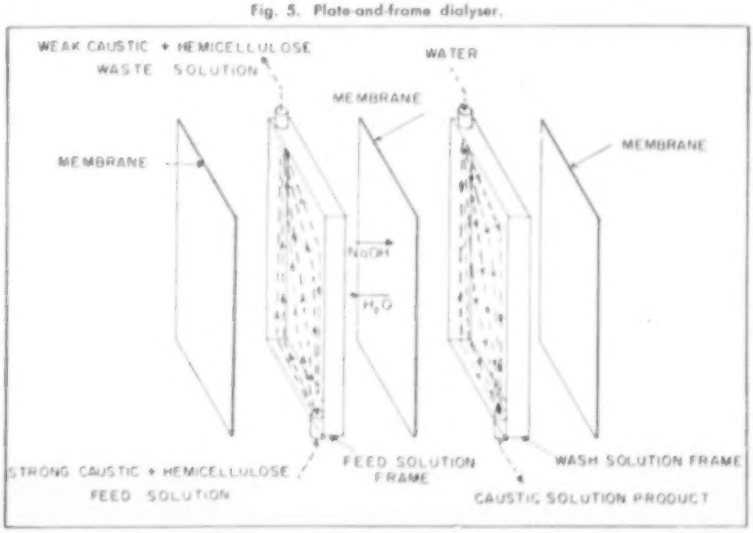


Fig. 5. Plate-and-frame dialyser.



electrodes and are capable of selective electrical transfer of either positively charged ion, cations, or negatively charged ions, anions. Since these membranes do not require chemical regenerants, these membranes are of potential economic use for treating more concentrated electrolyte solutions than can be treated by ion exchange with granular resins, which are attractive for treating dilute solutions of electrolytes. The many possible applications of these membranes can be classified as follows:

- Dilution or concentration of electrolytes
- Separation of electrolytes from nonelectrolytes

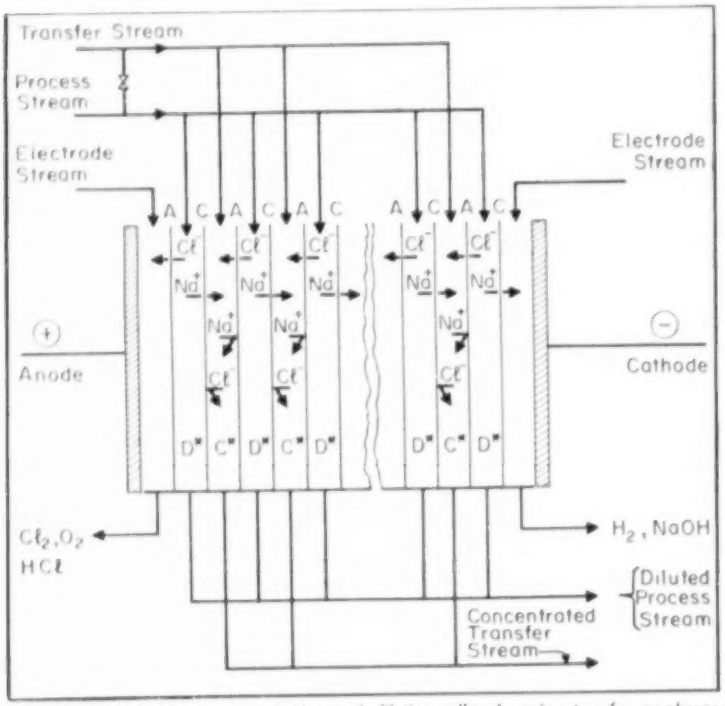


Fig. 12. Multi-membrane concentrating and diluting cells. A, anion transfer membrane; C, cation transfer membrane, Cl⁻, anion; Na⁺, cation; D*, diluting cell; C*, concentrating cell.

- Metathesis reactions
- Oxidation-reduction reactions
- Acid-base reactions
- Separation of ions of like charge.

The application of greatest interest, the electrodialytic desalting of water, is shown in Figure 12, where cation and anion permeable membranes are shown alternating sequence. Under the action of the applied d.c. e.m.f., salt is transferred from every other compartment and into the remaining compartments. As a secondary effect water is transported electroendosmotically with the ions through the membranes in rather large amounts, 0.1 to 0.3 liters/g.-equiv. of salt. The process is applicable to the desalting of any solution containing ionized material. An unusual example is the possibility of breaking azeotropes such as HCl-H_2O and HF-H_2O as shown in Figure 13. Figure 14 shows how silver bromide can be formed directly in a gelatin emulsion by simultaneously adding bromide and removing nitrate, all by electrical transport. Figure 15 shows how a suspension of calcium hydroxide can be reacted with a solution of sodium chloride to give calcium chloride and sodium hydroxide solutions.

In electrolysis reactions, a major problem is to prevent mixing of the electrode products. In the electrolysis of brine, Figure 16, an ionic membrane is used in place of an asbestos diaphragm to produce a caustic soda solution more or less free from sodium chloride. An interesting application in this field, is the reduction of uranyl to uranous chloride (Figure 17) where the membrane prevents loss of the chloride and its contamination with the anolyte.

The applications described are limited by the chemical stability of the membranes in the process solution or by fouling of the membranes with precipitates. The loss of membrane selectivity as concentration increases limits the economic solution concentration to less than 2 N.

A major problem in the application of electrodialysis with ion exchange membranes to practical processes is the lack of equipment design data. The work reported by E. A. Mason and T. A. Kirkham (6) will help solve this problem.

Of greatest interest is the need for optimizing the design because the current density in an electrodialytic cell is limited by concentration polarization at the membrane surface in the dilute chambers. Only about one half of the ions arriving at the membrane interface from the bulk of the solution are carried by electrical transport while the remainder arrive at the membrane interface by diffusional processes. When the ratio of the current density to the solution conductance reaches a maximum value, there is insufficient electrolyte present to carry all the current across the membrane, leading to dissociation of water to supply the requisite number of ions. This limiting value can be recognized by changes in the pH of the effluent streams. Values of the limiting polarization of sodium chloride in water are shown in Figure 18. The critical value occurs at the dilute end of an electrodialyzer used for demineralizing water and this limits the current density through the whole apparatus.

It is found advantageous to demineralize water by a cascade system of electrodialyzers, as shown in Figure 19. The number of stages, S, required where each stage removes the same fraction of the entering electrolyte, f_s, in order to achieve an over-all fractional reduction in the feed, f_o, is given by the equation:

$$(1 - f_s) = (1 - f_o)^S$$

Demineralization by electrodialysis is carried out at an optimum value of the current density. The demineralization capacity depends on the first power of the current density while the power losses depend on the second power of the current density. The power consumption, E_2 in kilowatt hours per pound equivalent of electrolyte, is given by the following equation:

$$E_2 = \frac{0.000126\, i A_p r_s F}{en}$$

where

i is the current density

A_p the open membrane area

r_s the electrical resistance in ohms for the membrane stack containing n cell pairs

e is the current efficiency

F is Faraday's constant.

In order to obtain pure water from

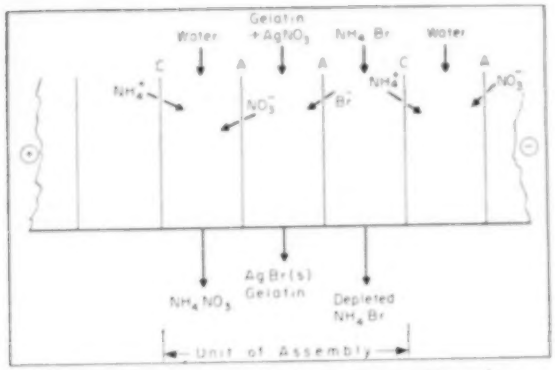


Fig. 14. Production of precipitates C: photographic emulsion.

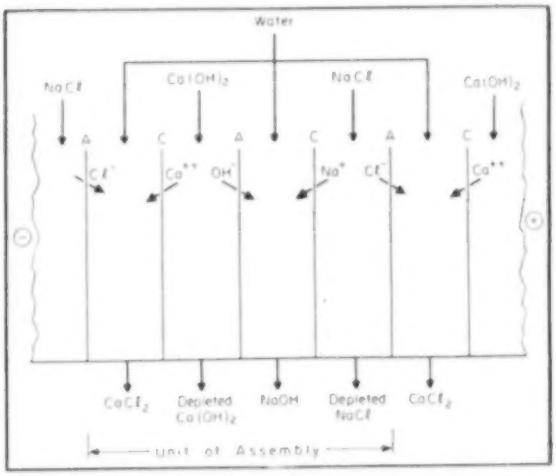


Fig. 15. Membrane cell for metathesis production of caustic from lime and salt.

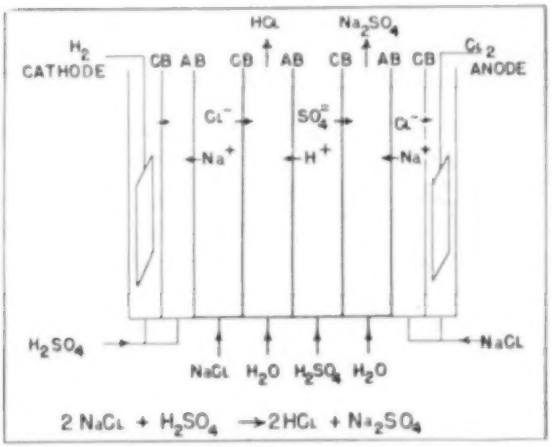


Fig. 20. Metathesis of sodium chloride with sulfuric acid. AB—anion barrier; CB—cation barrier.

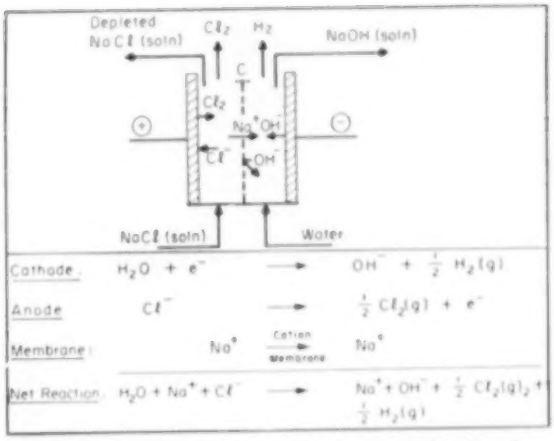


Fig. 16. Oxidation and base production, caustic-chlorine cell.

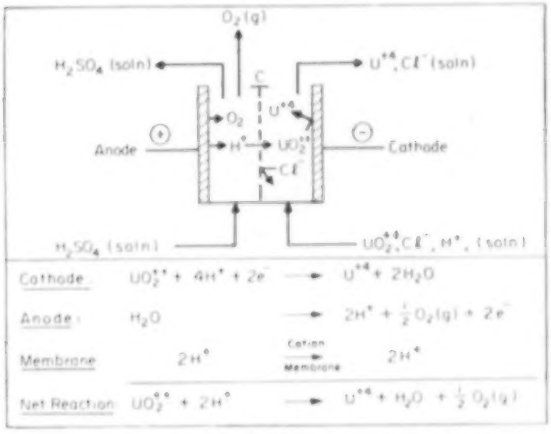


Fig. 17. Electrolytic reduction cell, uranium reduction.

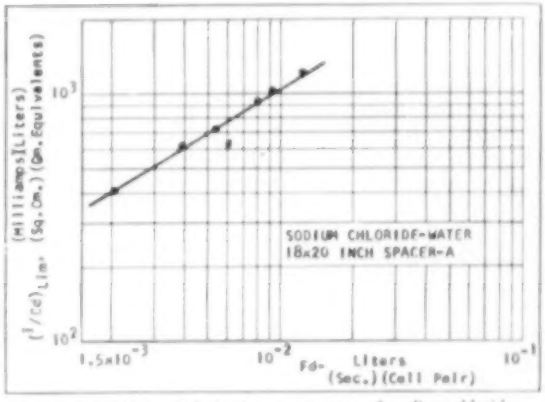


Fig. 18. Limiting polarization parameters of sodium chloride.

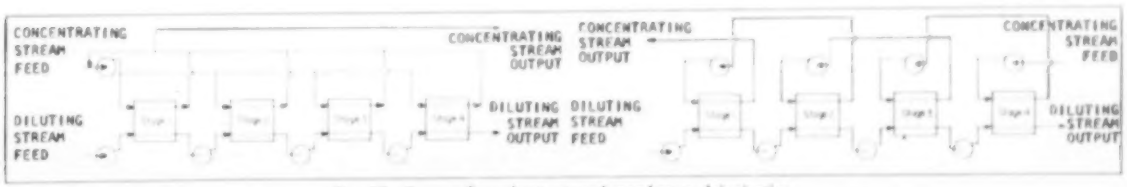


Fig. 19. Process flow sheet, staged membrane deionization.

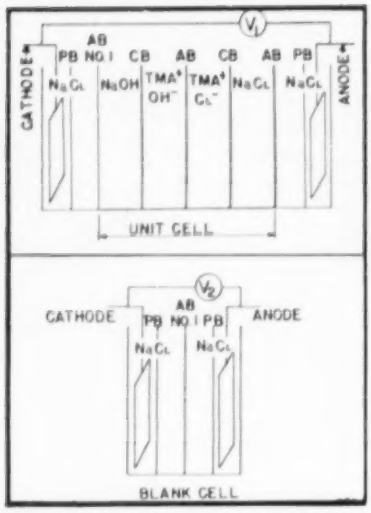


Fig. 21. Voltage drop across unit cell. Metathesis of TMACl with sodium hydroxide. AB—anion barrier; CB—cation barrier; PB—parchment barrier. $V_{unit\ cell} = V_1 - V_2$.

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SORPTION PROCESSES

A complete collection of the papers which provided the basis for this article will be published soon in paper binding and will be available at nominal cost.

Literature references cited by author Winger in the accompanying article correspond to chapters in the coming volume as follows:

1. Kammermeyer, Karl, "Gaseous Diffusion through Microporous and Adsorbent Membranes."
2. Lane, J. A., and J. W. Riggle, "Dialysis."
3. Henderson, W. E., and C. M. Sliepcevich, "Molecular Separations by Solution Ultrafiltration."
4. McKelvey, J. G., Jr., K. S. Spiegler, and M. R. J. Wyllie, "Ultrafiltration of Salt Solutions through Ion-exchange Membranes."
5. Mason, E. A., and W. Juda, "Applications of Ion Exchange Membranes in Electrodialysis."
6. Mason, E. A., and T. A. Kirkham, "Design of Electrodialysis Equipment."
7. Monet, G. P., "Metathesis Reactions Using Ionic Membranes."

sea water, only about 2.8 kw.-hr./1,000 gal. is theoretically required. Although electrodialyses have been carried out at low current densities with a power consumption as low as 10 kw.-hr./1,000 gal., commercial equipment for the demineralization of sea water is operated at an energy consumption of about 100-200 kw.-hr./1,000 gal. in order to approach a reasonable balance between cost of electrical energy and amortization of plant investment. The demineralization of brackish waters, containing about 3,500 p.p.m., is a more attractive area of economic application than sea water.

As shown in work reported by Monet (*7*) ion exchange membranes can be used in electrolytic processes for production of materials otherwise obtained in negligible quantity due to diffusional mixing of the products of electrolysis. For example, metathesis, or double decomposition, reactions appear to be a potentially promising area for applications of ion exchange membranes. The way in which such reactions can be carried out is shown in Figure 20 for the reaction of sodium chloride with sulfuric acid to give hydrochloric acid and sodium sulfate. The reactant solutions are pumped into the electrodialyzer where electrical transport of ions across the membrane occurs. The supposedly pure products are formed directly in solution and are withdrawn.

In exploratory studies on metathesis reactions carried out in this manner, it was noticed that the membranes were imperfect barriers to hydrogen, or acidic, and hydroxyl, or basic, ions. Since acids and bases are present in most solutions of interest in chemical manufacture, an experimental method was devised to measure the selectivity of ionic transport through these barriers, Figure 21. In this experiment, a six-compartment cell is used with the ionic membrane and the two adjacent compartments isolated from the two terminal electrode compartments by the intermediate buffer compartments shown. Current is applied for a given length of time and the total amount of both cations (+) and anions (−) transported across the barrier is calculated from Faraday's law. The amount of the leakage ion transported is measured by analysis of the compartment shown. By such experiments, the selectivity values shown in Table I were obtained. The selectivity is shown as the transport number of the leakage ion, which is the fraction of the total current carried by the leakage ion towards which the barrier is ideally impermeable. It can be seen that cation barriers allow as much as 0.5 of the current flow to be carried by hydrogen ions and anion barriers allow 0.3 of the current flow to be carried by hydroxyl ions. Calculations indicate this poor selectivity is caused partly by the Donnan equilibrium and partly by the high equivalent ionic conductances of hydrogen and hydroxyl ions relative to other ions.

Table 1.—Selectivity of Ionic Barrier Membranes

Barrier	Solutions		Permeable ion	Leakage ion	Transport no. leakage ion*
Anion	NaCl	NaOH	Na^+	OH^-	0.31
	Na_2SO_4	NaCl	Na^+	Cl^-	0.05
	NaCl	Na_2SO_4	Na^+	SO_4^{--}	0.003
	$MgSO_4$	$MgCl_2$	Mg^{++}	Cl^-	0.12
Cation	NaCl	HCl	Cl^-	H^+	0.52
	HCl	NaCl	Cl^-	Na^+	0.009
	NaCl	$MgCl_2$	Cl^-	Mg^{++}	0.0002

* Current density 90 amp./sq.ft.

WHAT'S IN SYMPOSIUM SERIES VOLUME 53

(Number 20, 1957—Liquid Metals Technology—Part I)*

Material Transport in Sodium Systems

Fred G. Haag

Results of a comprehensive three-year investigation into the cause and magnitude of atom redistribution in flowing sodium systems are summarized. The importance of various system parameters is discussed, and oxygen concentration and temperature are shown to be the significant variables. The problem of radioactivity which results from the growth of radioactive structural isotopes in typical sodium-cooled reactor systems is seen to be small. This conclusion is based on the results of the recently completed experimental program.

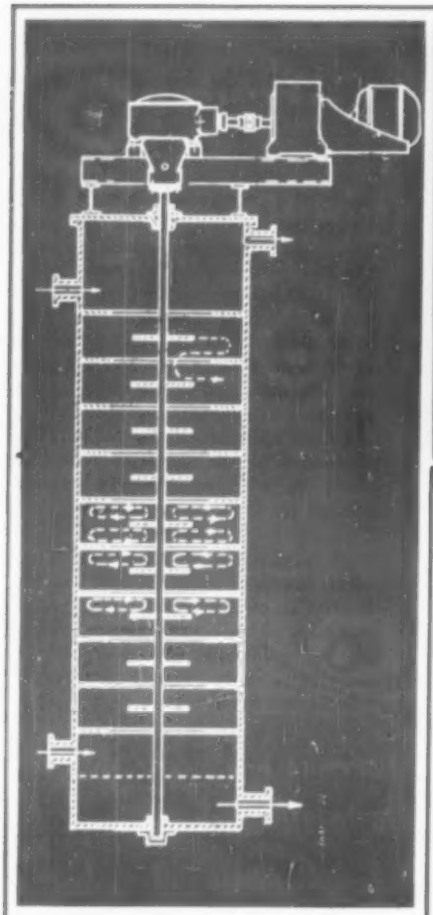
Pool-boiling Heat Transfer with Mercury

C. F. Bonilla, J. S. Busch, Arnold Stalder, N. S. Shaikhmahmud, and Arcot Ramachandran

Mercury was boiled on a horizontal low-carbon-steel plate of pressures from 4 mm. of mercury to 45 lb./sq.in.abs., depths of 2 to 10 cm., and heat velocities of 4,000 to 200,000 B.t.u./(hr.)(sq.ft.), with and without the addition of wetting agents. The nature of the boiling and the necessary temperature differential were observed.

** This concludes Part I of Volume 53, other abstracts of which appeared in the September and November issues of CEP.*

$4.25 to nonmembers; $3.25 to members; 84 pages. Obtainable from offices of A.I.Ch.E., New York.



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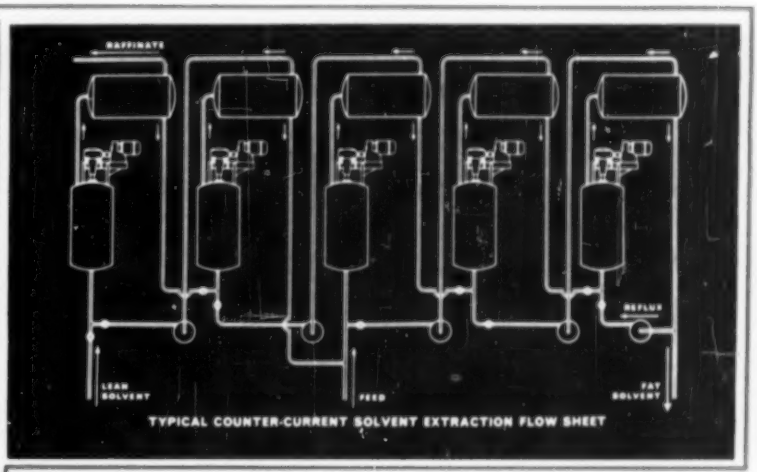

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STEEL AND CHEMICALS—MARRIAGE OF CONVENIENCE

First steel-industry production of pure coal chemicals in full swing at Jones & Laughlin.

By-product light oil, produced in coking operations at J&L steel plants in Pittsburgh, Aliquippa, Pa., and Cleveland, is now being processed in a new J&L plant at Aliquippa to make high-grade benzene, toluene, and xylene. Rated capacity of the new facilities is said to be 56,500 gal./day of the aromatic hydrocarbons (benzene, toluene, and xylene); product purity is claimed to exceed standard chemical industry specifications. Feature of the operation is that all of the by-product feed streams are converted into high-purity chemicals—no intermediates are produced.

Distillation column (height 130 ft.) distills off benzene, toluene, and xylene from coke oven by-product oil at Jones & Laughlin's Aliquippa, Pa., plant.

Two-Process Combination

Secret of the successful new development is the combining of two existing processes: the Udex process, licensed from Universal Oil Products; and the Hydrofining process, licensed from Esso Research and Engineering.

The Hydrofining operation uses a catalyst to promote reaction between sulfur compounds and hydrogen, the hydrogen also combining with non-aromatics in the oil to form compounds subsequently separated in the Udex process. Hydrogen for the process is produced by ammonia dissociation units.

The partially-refined material charged to the Udex unit (capacity 1,345 b/sd) is predominantly aromatic, this fraction containing about 70 per cent benzene, 20 per cent toluene, and 10 per cent mixed xylenes. Finished products are benzene of 5.4° C. (41.7° F.) solidification point, toluene containing less than 0.1 per cent saturated hydrocarbons, and a mixture of isomeric xylenes. Saturated hydrocarbons, separated by the process, appear as a by-product.

Badger Manufacturing was prime contractor for the $2,000,000 unit, also aided in adapting the Hydrofining process for the J&L installation.

Full ownership of Rem-Cru Titanium has been acquired by Crucible Steel Co. of America. The transfer was effected by an exchange of 150,000 shares of Crucible common stock for the entire half interest owned by Remington Arms Co. □

Work has now begun on a new mill addition and office building for the Superior Tube Co., Norristown, Pa. □

MAMMOTH BORON SOURCE IN PRODUCTION

Full-scale operations started at U.S. Borax & Chemical's new $20,000,000 open pit mine and refinery at Boron, Calif.

Adequate boron to meet the defense and industrial needs of the entire Free World for the next century is said to be assured by the opening of a new plant in the Mojave Desert, 130 miles northeast of Los Angeles, site of an ore deposit containing some 70 per cent of the Free World's known reserves.

No secret is the impetus behind the sudden interest in boron. The desperate race for development of high-energy boron compounds for jet and missile fuels has seen the authorization this year of two major chemical processing installations: Callery's $38,000,000 Muscogee, Okla., facilities operated for the Navy; and a $33,000,000 plant at Niagara Falls, run by Olin-Mathieson for the Air Force. No stranger to the nuclear field, boron is also used extensively for shielding and for reactor control devices.

An unusual development has been the introduction of Borazon (cubic boron nitride) by General Electric. Processed under extremely high pressures and temperatures, the new substance can withstand temperatures in excess of 3,500° F. (Diamonds burn in air at about 1,600° F.)

More mundane but larger uses for boron are the glass and ceramic industries, various agricultural applications, and a hundred miscellaneous industrial uses including fire retardants, fluxes for metal refining, magnesium founding, and as a component of special steels. Total U. S. production in 1955 was more than 700,000 tons.

Aerial view of huge new open pit mine and refinery of United States Borax and Chemical Corporation, dedicated November 13. Facilities cover 80-acre site.

Big Ditch

Nine million tons of earth were removed to reach the ore deposit at a depth of 137 feet. The pit is now 175 feet deep. Processing equipment is conventional—primary and secondary crushers, dissolving plant, thickeners, anhydrous borax plant, granulating plant, and storage silos.

At SOHIO Petrochemical Plant:

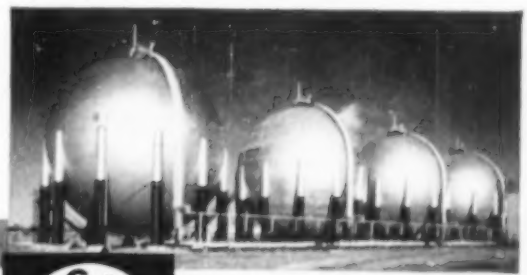
CB&I-Built tanks store 83% ammonium nitrate

Stainless and Aluminum Construction extends useful life of storage structures for ammonia and derivatives

At Sohio Chemical's $17 million ammonia plant, near Lima, Ohio, extensive use was made of stainless steel and aluminum for tanks used to store the highly corrosive products of this new petrochemical operation.

Among other structures, CB&I designed, fabricated and erected the two 80-ft. diameter by 40-ft. high aluminum tanks shown above, built of 54-S Aluminum. They are designed to hold 35,000 bbls. each of ammonium nitrate.

The handling of special metals, including design of structure, fabrication and erection, is a specialty—and an art with CB&I. Our plants are staffed, experienced and equipped to handle special alloys and to fabricate from a variety of cladding materials. Included is Hortonclad®, produced by the CB&I high-strength, vacuum-bonding process. Write our nearest office for further details.



OTHER CB&I STRUCTURES at Lima plant include a 30-foot diam. 304ELC solid-stainless tank for nitric acid storage, 54-S aluminum drums for ammonium nitrate solution and the four 20,000 barrel Hortonspheres® above.

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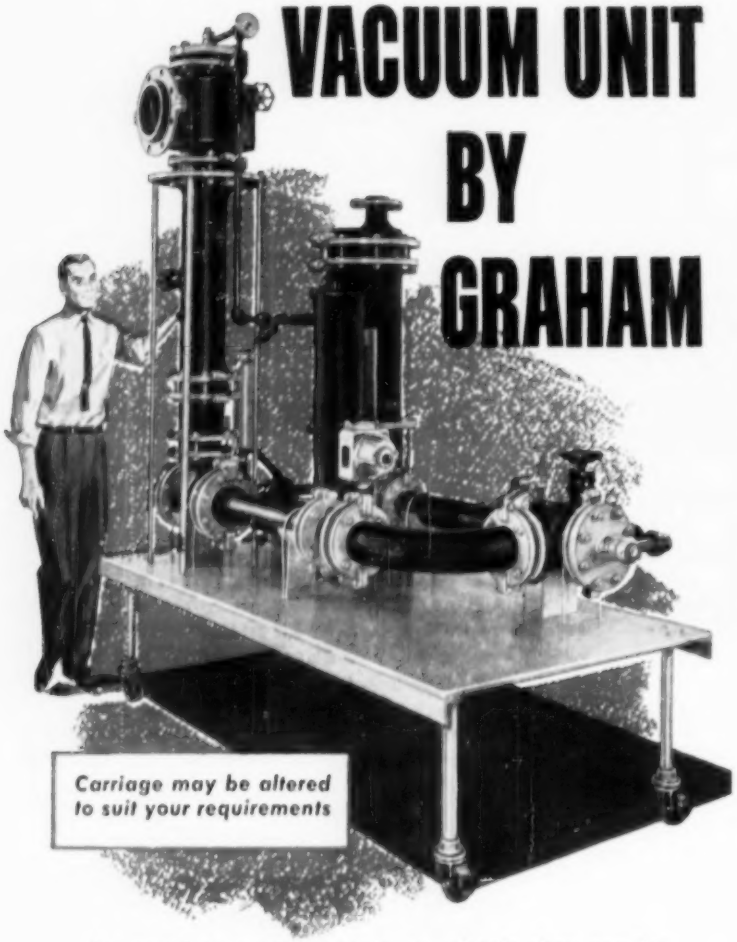

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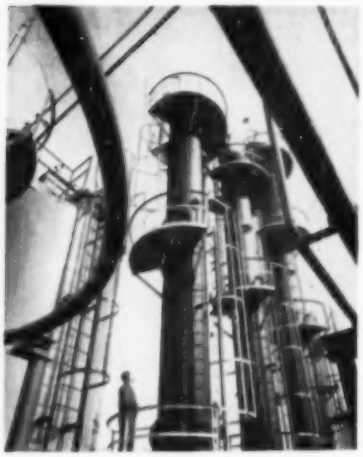
CELANESE EXPANDS INTO ACRYLIC ESTERS

First use of new B. F. Goodrich acetic acid - formaldehyde process. Both raw materials are products of Celanese' Bishop, Texas plant.

Immediate production at Celanese' Pampa, Texas plant will include methyl, ethyl, and butyl acrylates, with markets for higher esters to be developed. Fifteen million lb./yr. output, already in tank car shipments, is expected to make Celanese a major source of this rapidly growing family of petrochemicals.

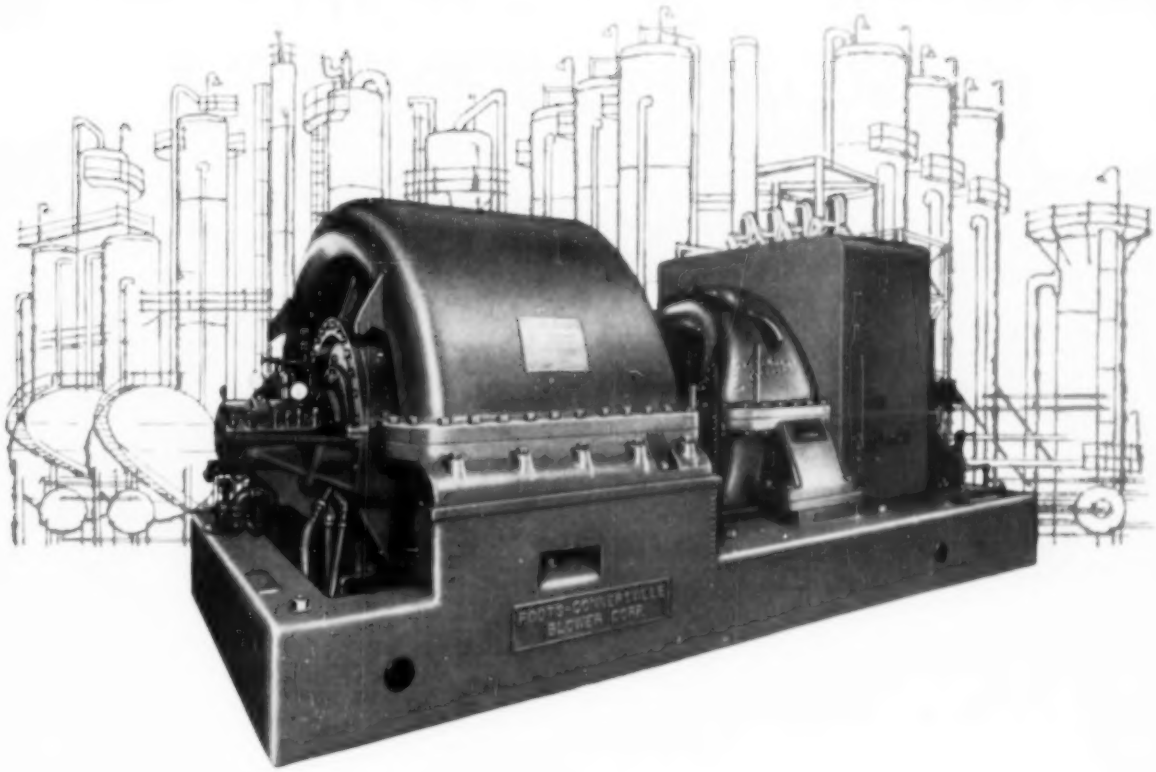


Continuous synthesis and purification of acrylate esters takes place in these distillation towers at new Pampa, Texas, plant of Celanese Corp. of America.

Acrylic polymers derived from acrylate esters are clear, colorless, tough, rubbery compounds, were first used commercially in leather finishing and as an interlayer for laminated safety glass. They are now used in leather, textile, paint, paper, and other industries.

Disodium methyl arsonate production facilities are being expanded at Ansul Chemical's Marinette, Wis., plant. A new $40,000 building is to be completed by late 1957. □

Metallic stearates will be manufactured in Canada by Witco Chemical Co., Ltd. A new plant, southwest of Toronto, will be in production early in 1958, says Witco. Used principally in the grease, cosmetic, plastic, rubber, and paint industries, the metallic stearates find application as waterproofing agents, gelling agents, lubricants, and paint flatting agents. □



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MANAGEMENT GROUP COVERS WIDE AGENDA AT WINTER MEETING

Titanium, tonnage oxygen, industrial safety, new product development provided some of the high spots at MCA's recent New York meeting.

As top executives of companies representing some 95 per cent of U. S. chemical production met recently at the Hotel Statler in New York for the Semi-Annual Meeting and Winter Conference of the Manufacturing Chemists Association, the outsider was afforded a rare glimpse of what top chemical management is thinking about in these critical times. Topics at the one-day New York meeting ranged from new technical developments to the frontiers of advertising psychology.

Titanium, Oxygen

"Titanium—The Chemical Industry's New Material of Construction," was, for chemical engineers in particular, a highlight of the panel session on Reactive Metals, moderated by Stanley Norwood of Electromet. "Titanium equipment is coming down in price, not only because of the decrease in mill product prices, but because many pioneering fabricators have gained experience in the working of titanium," pointed out C. I. Bradford of Rem-Cru Titanium. Leading chemical firms which have blazed the trail to wider commercial use of this new material are Wyandotte, DuPont, Pennsalt, and Freeport Sulphur, said Bradford, who illustrated his talk with descriptions, case histories, and photos of many of the actual pieces of equipment involved.

Chemical process applications of tonnage oxygen are increasing at a rapid pace in the steel industry, according to D. E. Babcock, consultant to Republic Steel, in a presentation which covered applications of chemistry to problems of mining, blast furnaces, open hearth furnaces, and pneumatic processes of steelmaking.

A glimpse into the perhaps-not-so-distant future was provided by W. D. Manly, associate director of ORNL, who, starting from the standard components of existing nuclear reactors, came up with a convincing tentative design for the first nuclear-powered automobile.

Industrial Safety

Compromise is inherent in any industrial safety program, according to C. S. Hannen, production manager, Explosives Division, Canadian Industries, Ltd., speaking at the session on Organization of an Effective Safety Program. "The plant manager's responsibility," says Hannen, "is *to operate a safe plant*, and the word 'operate' must mean 'operate at a profit.' The safest plant in the world, operated at a loss, will soon be the safest *shut-down* plant in the world, and the safest workers in the world will be collecting unemployment benefits."

The psychological implications of safety were emphasized by C. U. Dernehl, assistant medical director for Union Carbide. "All the mechanics of a safety program may be worked out in the most minute detail, but in the final analysis, the mental responses of the employee in thinking safely or unsafely are the determining factors in the success of such a program."

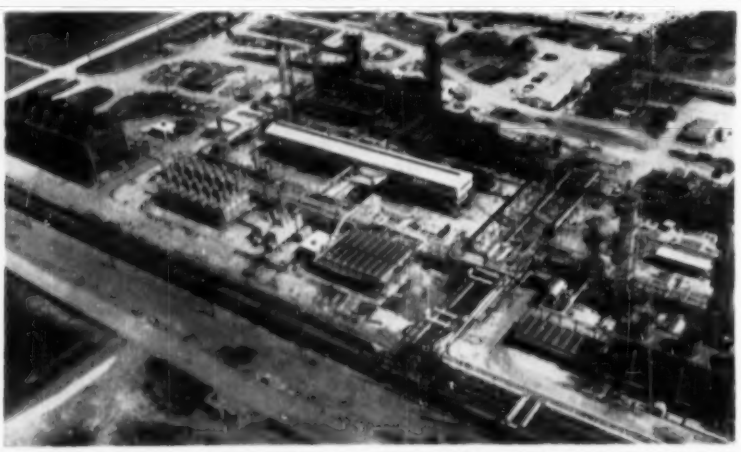
The over-all validity of safety programs was driven home by S. F. Spence of American Cyanamid. "In no instance," says Spence, "can we shrug off the cost of accidental losses by saying 'the insurance company will pay.' There is no such thing as a free lunch. We save ourselves money by preventing our losses."

Citizenship Is Part of Business

Businessmen, as individuals, said John McCarty, G.E. consultant on group relations (speaking at the panel on Communicating Industry Viewpoints), should be "willing and eager to serve . . . the community in any reasonable way which will contribute to the political, moral, economic, and social objectives needed to make their community a better place to live, work, and raise a family. As parents and citizens," he added, "businessmen should become active in the political affairs of their community. Politics is only as dirty as the people permit it to be."

"A company's public relations program depends for its success on the behavior of well-informed, well-adjusted employees who, *by their very words and attitudes*, convey more about the company than anything it

(Continued on page 72)



One of the world's largest ethylene plants is now in successful operation at Sweeny, Texas, for Phillips Chemical. Designed and constructed by Stone & Webster, the plant has an annual capacity of 180 million pounds which can be increased easily to 290 million pounds. Product ethylene will flow through a 70-mile pipeline to Phillips' recently-constructed polyethylene plant at Pasadena, Texas.

Claimed to be the first high-precision computer center in the United States, the Manhattan Computer Center will be opened in New York City in February, 1958, by Mid-Century Instrumatic Corp. A staff of specialists in the design and operation of analog computers, in mathematical and problem analysis, in programming, and in the analysis of methods and systems will be available to assist computer users. □

A synthetic rubber pilot plant and laboratory, owned by the Government since 1944, has been purchased by Firestone Tire & Rubber and will be integrated into its synthetic rubber operations. The facilities, used intensively during World War II, have since been operated by the University of Akron for the study of synthetics. □

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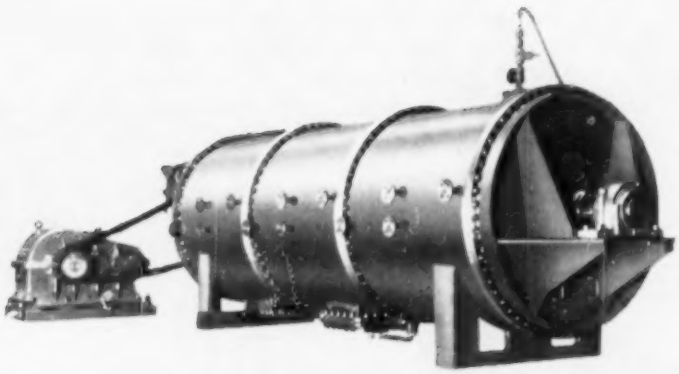
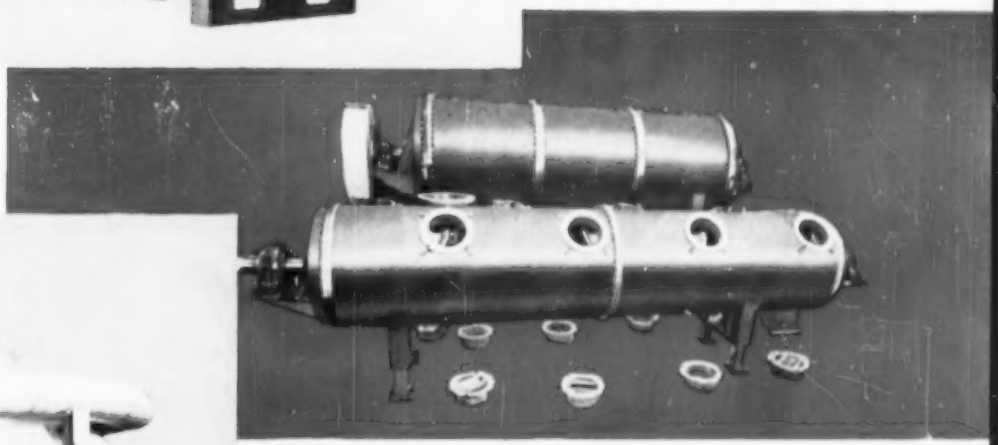
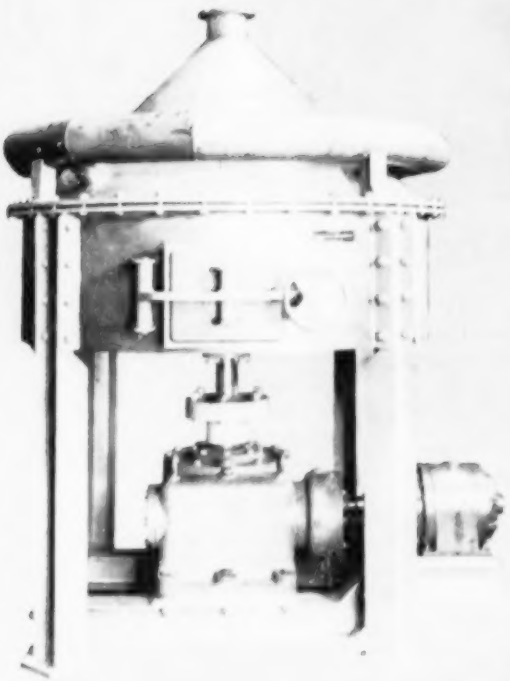


1. BATCH DRYERS—5' dia. x 16' long Bethlehem THERMOCOIL (Coil cast in wall) Batch Dryer. Material processed passes thru three stages: The feed material is in "soupy" form; as it dries it becomes a plastic mass; finally it turns to a powder. This three-purpose dryer is an excellent example of how Bethlehem's background of engineering helps manufacturers cut their equipment costs.





2. CONTINUOUS DRYER—In foreground, being assembled is 44" diameter 19' long Continuous Horizontal Dryer. Fabricated steel construction utilizing Hastalloy plow type agitators (seen through ports) 40 HP drive. This dryer is used to dry salt, evolving organic vapor product, on a continuous basis. Heat is provided through jacketed body. (In background is a Thermocoil dryer representing a repeat order of the batch dryer described under 1.)

3. PAN BATCH DRYER—5' 2" diameter Bethlehem Pan Dryer of stainless steel construction with scraped and jacketed flat bottom. Agitator provides plowing action to break up and circulate material. Agitation also provides for self-discharge through quick opening discharge door. Used to dry certain naval store products, rare metals and other materials handled more economically in a small scale batch operation.

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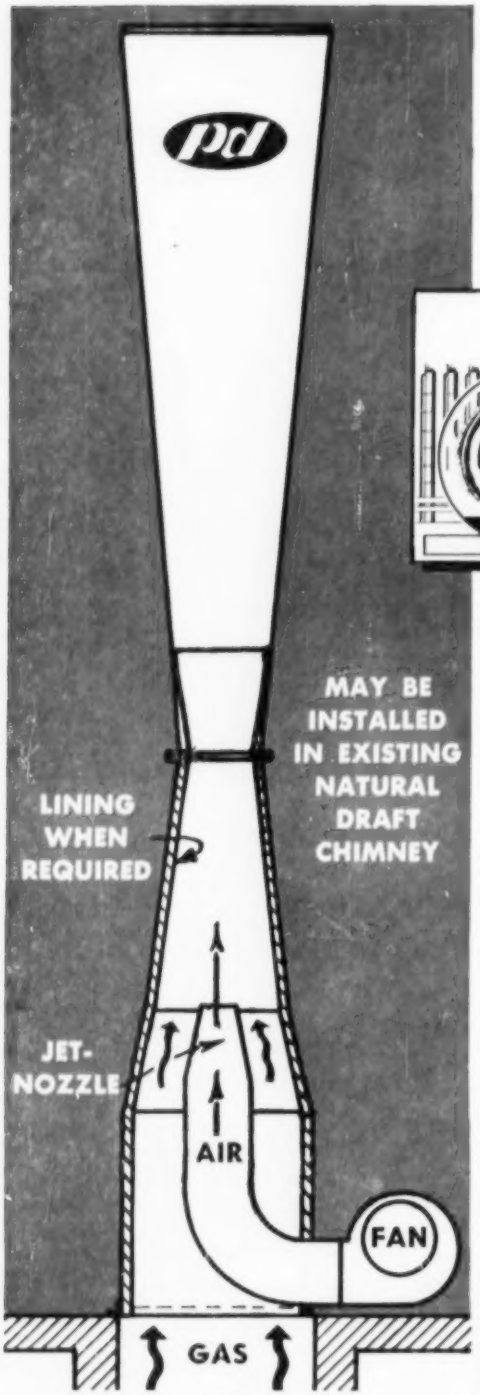

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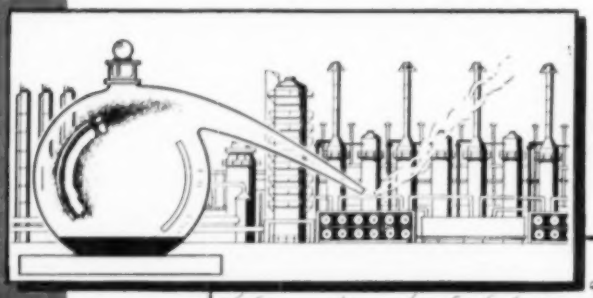

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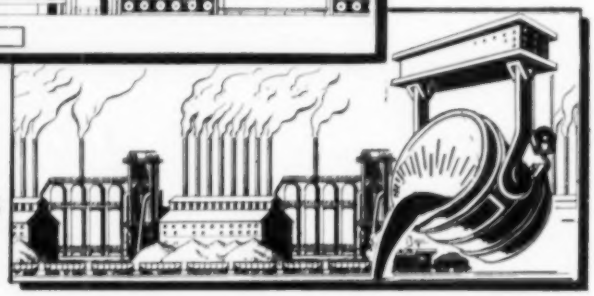

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301 Stainless Steel Specificaton Chart. File-size chart shows chemical analysis requirements for Military, Air Force - Navy Aeronautical, and Federal specifications. Peter A. Frasse & Co.

302 Yttrium Oxide Data Sheet. Gives data useful for high temperature applications such as melting point, specific heat, thermal expansion. Research Chemicals, Inc.

303 Neopentyl Glycol Data Booklet. Gives application including polymeric plasticizers, polyurethane foams, unsaturated polyester resins, monoesters, and as modifier of alkyd resins. Eastman Chemical Products, Inc.

304 Epoxic'ation Reaction Procedures. Two new procedures for in-situ epoxidation reactions with resin catalysts described in new bulletin from Becco Chemical Division, Food Machinery and Chemical Corp.

305 Antifoam Information Sheet. Factual information describing properties and applications of Hodag Antifoam TBX, specially designed for coatings and adhesives. Hodag Chemical Corp.

306 Booklet on Superlose and Ramalin. Brochure from Stein Hall & Co. gives physical and chemical properties of the amylose and amylopectin fractions of starch.

307 Flexible Teflon Tubing. Bulletins from

(Continued on page 60)

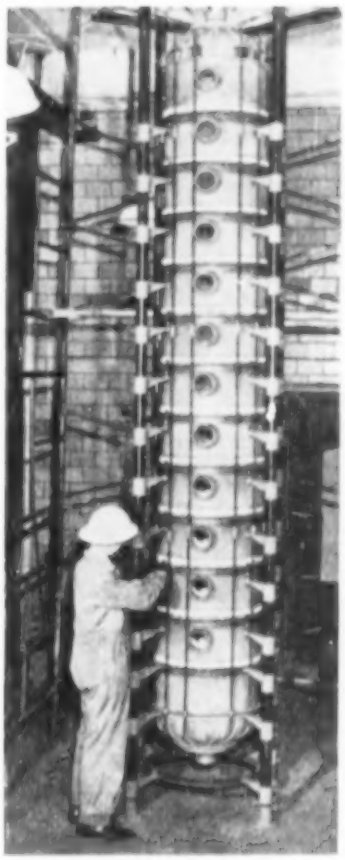
LARGEST ALL-GLASS BUBBLE CAP COLUMN MEETS SPECIAL PROCESSING NEEDS

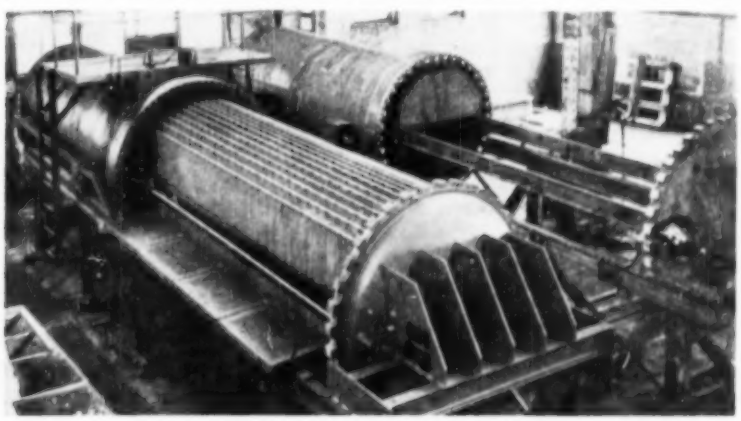
Sixteen feet high, 23½ inches in diam., and weighing about 1 ton, an all-glass bubble cap distillation column has been manufactured by Corning Glass Works for use in the production of metallic silicon. Glass construction was specified by the user to meet strict purity requirements.

Thirteen armored Pyrex brand cylindrical sections make up the column. Included are two end pieces and 11 pieces with four-inch conical pipe flange connections. Sections and plates are placed one atop the other, the unit being held together by tie rod construction. Teflon envelope-type gaskets are placed between the sections to effect the seal. Between the armored sections are 12 of Corning's Multiform bubble cap plates of Vycor brand glass (96 per cent pure silica). In the Multiform process, powdered glass is slip cast, then fused to make possible formation of complex shapes. Plates in the pictured column are some of the largest parts ever made by this process, weigh about 65 lb. each.

Previous glass columns of the same diameter have contained as many as six glass plates. With the added plates of the 16-ft. column, there is increased assurance of product purity. The giant column is the first of two ordered by the user.

For further technical information on this and other types of glass chemical processing equipment, circle number 362 on Data Post Card.





RETRACTABLE SHELL-TYPE FILTER CLARIFIES GREEN SODIUM ALUMINATE LIQUOR

Originally developed by the Goslin-Birmingham Mfg. Co. for the Reynolds Metals Alumina Plant at Corpus Christi, Texas, a 2,000 sq.ft. retractable shell filter has proved to be entirely satisfactory for clarifying green sodium aluminate liquor. Ten such units are being installed by Reynolds in their current expansion program at Corpus Christi, and a total of 45 more have been purchased by two other alumina companies.

(Continued on page 66)

CEP Data Service

Engineering Data . . .

MATERIALS

301 Stainless Steel Specificaton Chart. File-size chart shows chemical analysis requirements for Military, Air Force - Navy Aeronautical, and Federal specifications. Peter A. Frasse & Co.

302 Yttrium Oxide Data Sheet. Gives data useful for high temperature applications such as melting point, specific heat, thermal expansion. Research Chemicals, Inc.

303 Neopentyl Glycol Data Booklet. Gives application including polymeric plasticizers, polyurethane foams, unsaturated polyester resins, monoesters, and as modifier of alkyd resins. Eastman Chemical Products, Inc.

304 Epoxic'ation Reaction Procedures. Two new procedures for in-situ epoxidation reactions with resin catalysts described in new bulletin from Becco Chemical Division, Food Machinery and Chemical Corp.

305 Antifoam Information Sheet. Factual information describing properties and applications of Hodag Antifoam TBX, specially designed for coatings and adhesives. Hodag Chemical Corp.

306 Booklet on Superlose and Ramalin. Brochure from Stein Hall & Co. gives physical and chemical properties of the amylose and amylopectin fractions of starch.

307 Flexible Teflon Tubing. Bulletins from

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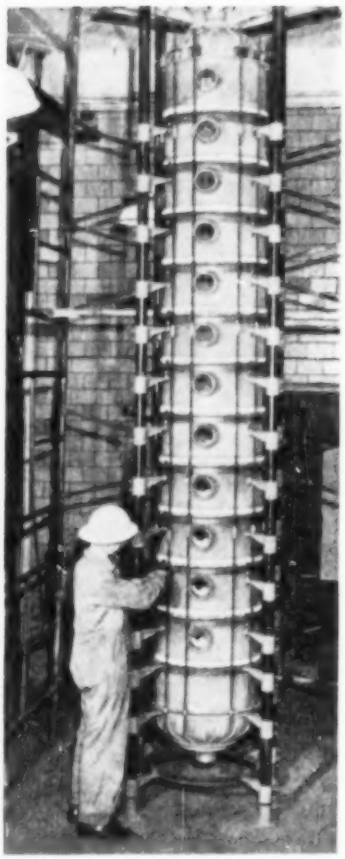

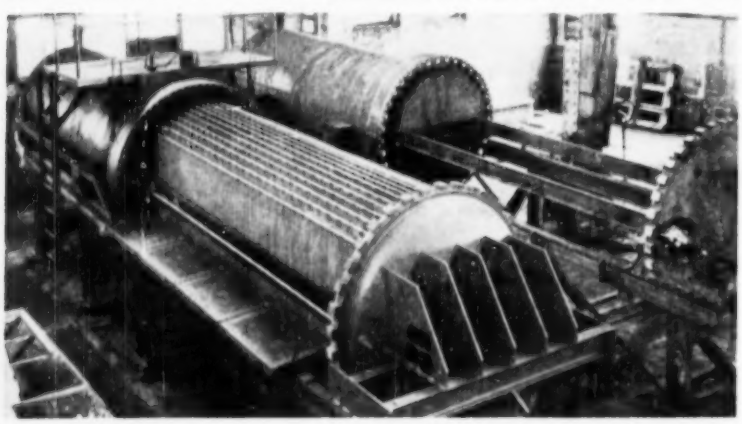

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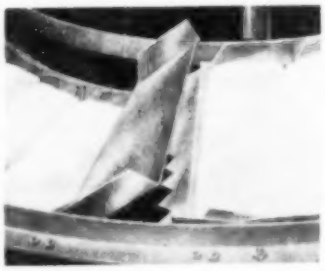
(Continued on page 66)

DEVELOPMENTS OF THE MONTH (*Cont.*)



364 Tilting Tray Turbo Dryer. A new design for extremely fine, powdery materials which cannot be tumbled or dropped without excessive dust losses is offered by Wyssmont Co. A rotating system of tilting trays permits the product to slide slowly from the upper tray to the next tray below, thus transferring the product with a minimum of entrainment during its downward travel through the dryer. The tilting trays are stacked in annular fashion around the Turbo-Fans which circulate the drying medium gently over the product trays. As the stack rotates slowly, the individual trays of each shelf are successively caused to tilt gradually as they pass a stationary cam, sliding the contents onto the next lower shelf.

Wyssmont is now building a small packaged unit and two large field-erected units incorporating the new tilting-tray feature. Each will serve as a combination dryer and reactor. Details are available from the manufacturer. Circle number 364 on Data Post Card.

(Continued on page 57)

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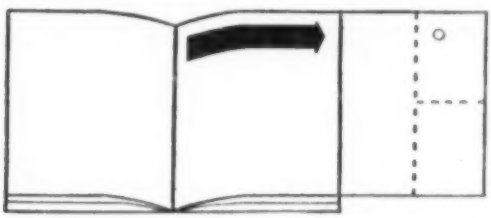

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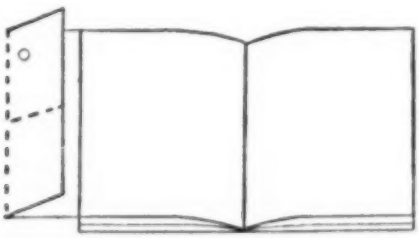

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DEVELOPMENTS OF THE MONTH

365 Steel Product and Warehouse Catalog. Crucible Steel Co. of America announces the availability of a new 232-page product and warehouse catalog. Designed for purchasing agents and steel users, the catalog describes over 700 products available from stock at warehouses throughout the country. The book lists 16 categories of special purpose steels, including high speed, tool, stainless, alloy, and machinery, available in 16,000 grades and sizes. Over 20 estimating, conversion, and weight tables are also included. For a copy of the catalog circle number 365 on Data Post Card.

366 Booklet on Acrolein and Derivatives. A new 40-page booklet on acrolein and derivatives has just been released by Union Carbide Chemicals Co. The first half of the booklet outlines the chemistry of acrolein and methacrolein. The second half contains properties and uses of 14 acrolein derivatives now available. The booklet also contains an extensive bibliography of acrolein chemistry, references to other literature supplied by Carbide, and a statement of availability. Acrolein is a simple, unsaturated aldehyde that reacts at both the vinyl group and the carbonyl group. As an unsaturated compound, it adds water, alcohols, and halogens at the double bond and undergoes Diels-Alder reactions. As an aldehyde, it reacts with alcohols and polyols to form unsaturated acetals. Acrolein and several of its derivatives are available in tank car quantities. Methacrolein, available in drum quantities, undergoes many of the reactions of acrolein to produce methyl-substituted derivatives. For a copy of the booklet circle number 366 on Data Post Card.

367 Mixer Catalog. A new 65-page catalog from Philadelphia Gear Works permits catalog selection of complete paddle and turbine type fluid mixers. Extensive selection tables are backed up by a discussion of the design principles utilized for development of the tabulated data. Particular attention is given to the practical aspects of scale-up, gas-liquid contacting, promotion of reaction, heat transfer, dissolving action, dispersion, and crystallization. Many charts are provided for easy reference. Circle number 367 on Data Post Card.

BASIC THEORETICAL PAPERS

in chemical engineering appear quarterly in the A.I.Ch.E. Journal, published by the American Institute of Chemical Engineers. For further information, circle number 368 on Data Post Card.

(Continued on page 60)

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4A Demisters & Liquid-Liquid Extractors. Bulletins from Otto H. York Co. and York Process Equipment Corp. on Yorkmesh Demisters and York-Scheibel Liquid-Liquid Extractors.

6A Process Equipment. Crystallizers, heaters, evaporators, heat exchangers, mixing and blending equipment, processing vessels, converters. Struthers Wells Corp.

7A Controlled-Volume Pumps. Bulletin from Lapp Insulator Co. gives applications, flow charts, description, and specifications of manually-controlled and auto-pneumatic models in various capacities and constructions.

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12L Mix-Mullers. The Simpson Mix-Muller combines the advantages of batch mixing with the adaptability and flexibility of continuous processing. Simpson Mix-Muller Division, National Engineering Co.

13A Carbon Electrodes. Custom-made anodes can help reduce operating costs. Great Lakes Carbon Corp.

15A Heat Transfer Equipment. Bulletin from Allis-Chalmers describes ribbon flight dryers, rotary kilns and dryers, air-quenching coolers, other heat transfer equipment.

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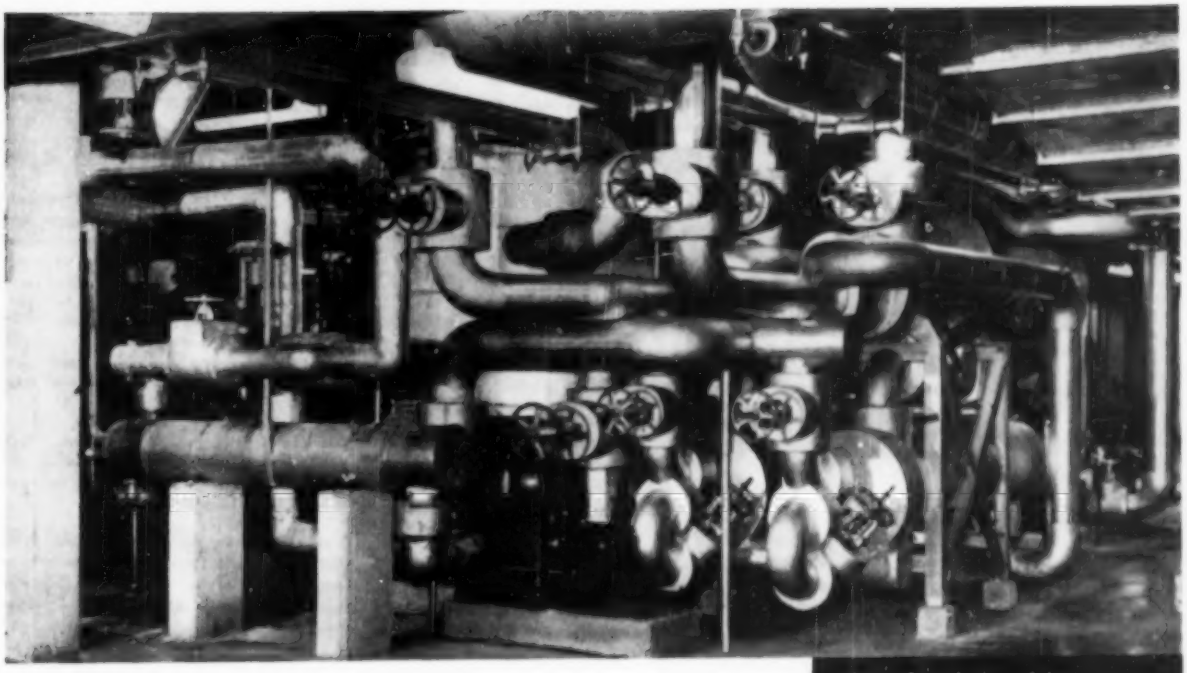
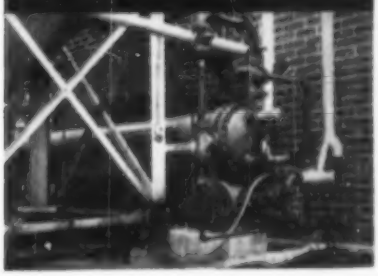


Above: General view of heat recovery system where shell-and-tube type heat exchangers recover heat from contaminated condensate before it goes to waste.

Below: Specially designed heat exchanger of nickel construction cools caustic at the rate of 5,890,000 Btu per hour.



P-K Heat Exchangers give Coats & Clark accurate temperature control of processing and refrigeration

Coats and Clark is well known throughout the textile industry for their outstanding mercerizing, dyeing, and bleaching processes in their 7½ million dollar thread mill in Toccoa, Ga. Accurate temperature control in these processes which convert gray thread to finished thread is most important . . . and is assured by the use of several P-K heat exchangers. In addition, P-K heat exchangers are also used in Coats & Clark's refrigerating system to condense refrigerant and to cool water.

A special P-K heat exchanger of nickel construction is used for cooling caustic, diluted from 73% concentration to 50%. The dilution increases the caustic temperature to 240°F and the nickel exchanger cools it down to 110°F.

Three more P-K exchangers are used in the refrigeration system of the plant. One, a chiller measuring 24" x 184" with a capacity of 246 gpm, is used for office air conditioning; a second chiller, measuring 12¾" x 148" with a capacity of 24 gpm, chills water which is subsequently used in the processing operation to 45-50F; the third exchanger serves as a freon condenser—a shell and tube exchanger, 14" x 152", it has a capacity of 1,851,000 btu per hour.

No downtime has ever had to be charged to heat exchanger trouble, and no maintenance other than routine inspection has been required. All of the heat exchanger equipment complies with the ASME unified pressure vessel code.

Dependable, trouble-free installations like these are the reasons why more and more processors and engineers are turning to P-K for their exchanger needs. P-K invites your inquiries about the design and fabricating of heat exchangers. Write, phone, or visit the Patterson-Kelley Co., Inc., 1712 Warren Street, East Stroudsburg, Pa. 6

Patterson Kelley

Chemical and Process Division

Heat Exchangers • Converters • Storage Water Heaters • Condensers • Storage Chillers
Oil Heaters and All Types of Heat Transfer Equipment

MATERIALS

(Continued from page 55)

Pennsylvania Fluorocarbon Co. give complete data on properties, including tensile strength, chemical resistance, upper service temperature, heat aging, etc.

308 New Gasket Material. Brochure from Metal Textile Corp. describes use of Metex Tray-Seal to reduce leakage across fractionating trays.

309 Brochure on Sulfonates. 12-page bulletin describes origin and manufacture of petroleum sulfonates, details behavior, functional properties, and applications. L. Sonneborn Sons, Inc.

310 Silicone Rubber Bulletin. Describes electrical insulating advantages of Silastic, new Dow Corning silicone rubber. Special section on use of room temperature vulcanizing. Dow Corning Corp.

311 Primary Amyl Acetate. Properties, specifications, applications, in new technical bulletin from Union Carbide Chemicals Co. Includes data on water extractions and on performance in lacquers.

312 Tubing Steels Stress Rupture Data. 4-page folder from Babcock & Wilcox gives results of stress rupture tests on fourteen different steels at temperatures from 850 through 1,800° F.

314 Stainless Steel Catalog. Sharon Steel Corp. offers illustrated 32-page catalog with description, chemical composition, strength factors, physical properties, typical applications for wide range of stainless steels, including the 200, 300, and 400 series.

315 Bulletin on Thioglycolic Acid. 20-page catalog from Evans Chemetics, Inc. titled "Properties, Reactions, and Uses of Thioglycolic Acid."

316 Citraconic Anhydride. Technical data and samples available from Chas. Pfizer & Co. Shows promise in curing epoxy resins, preparing polyester resins, serving as chemical intermediate.

317 Technical Brochure on Genthane-S. 20-page booklet on Genthane-S, General Tire & Rubber Co.'s new polyurethane elastomer. Details of physical properties and characteristics under various conditions.

318 Plastics Catalog and Price List. Kaufman Glass Co. offers 62-page catalog and price list on sheets, rods, tubes in wide variety of plastic materials.

319 Metallic Media for Solids-Liquid Separation. Bulletin from Multi-Metal Wire Cloth Co. describes line of wire cloth, filter cloth, perforated metal sheets.

320 Filter Aid Data Sheet. Gives technical details on Tenn-Flo sterile filter powders for industrial clarifications ranging from edible oils and sugar syrups to gums and varnishes. Tennessee Products & Chemical Corp.

321 Prestressed Concrete Cylinder Pipe. In sizes from 16 to 84 in. for pressures from 50 to 300 lb./sq.in. High resistance to corrosive tuberculation. Bulletin from Gifford-Hill-American Co.

322 High Temperature Insulation. Bulletin from H. I. Thompson Fiber Glass Co. contains comparison chart on fibrous high temperature insulation, other selection data.

323 Pressure Tubes. Corrosion data, properties, specifications on line of pressure tubing in carbon and stainless steel for the process industries. Bulletin from Republic Steel Corp., Steel and Tubes Division.

324 Filter Cloth Catalog. Chemical resistance, corrosion resistance, abrasion resistance, available yarn forms for filter cloth in Nylon, Vincel, Orlon, Dynel, Teflon, Saran, cotton, glass, polyethylene, special filter papers. National Filter Media Corp.

325 Isocinchomeronic Acid. Suggested as intermediate in preparation of pharmaceuticals, insecticides, polymers, and dyestuffs. Small samples available without charge. Ansul Chemical Co.

326 Organic and Inorganic Chemicals. Properties, typical applications of more than one hundred inorganic and organic chemicals described in new catalog from Pennsalt Chemicals Corp., Industrial Division.

327 Three Bulletins on Guar Gum. Properties, uses, applications of guar gum in chemical processing, pulp and paper, and mineral dressing industries. General Mills, Inc.

328 Low Temperature Plasticizers. Technical bulletin from Emery Industries, Inc. gives details of Plastolein 9078 LT, new low cost plasticizer for vinyls.

329 Anhydrous Ammonia Bulletin. Specifications, typical analysis, applications of anhydrous ammonia covered in 11-page bulletin from Henry Bower Chemical Manufacturing Co.

330 Vinyl Plastisol Bulletin. 28-page brochure from Monsanto Chemical Co. gives full technical details on preparation and processing of vinyl plastisols.

331 Data on Beryllium Oxide. Physical and mechanical properties, typical analyses of "Berylco" beryllium oxide contained in 8-page folder from Beryllium Corp.

332 Suspension Process fo PVC Resins. Brochure from Scientific Design Co. gives details of their suspension process for manufacture of PVC resins.

333 Sheet Packings. 8-page bulletin from Crane Packing Co. gives detailed specifications, engineering, application, and testing data on complete line of industrial sheet packings.

334 Aluminum Design Guide. Technical booklet from Reynolds Metals Co. serves as basic guide on design, fabrication, and application of aluminum tanks and processing vessels.

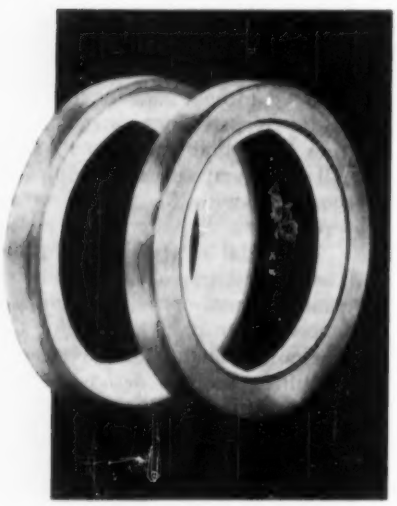
335 Corrosion-Resistant Plastic Pipe. Catalog from Fibercast Corp. describes new pipe constructed of centrifugally cast thermostat reinforced epoxy resins with multiple layers of seamless braided glass fibers.

336 Calcium Carbonates in Neoprenes. 11-page techincal bulletin "Diamond Precipitated Calcium Carbonates in Neoprenes." Many tables and charts. Diamond Alkali Co., Silicate, Detergent, Calcium Division.

337 Methyl Butanol Derivatives. Technical bulletins from Air Reduction Chemical Co. describe properties, uses of methyl butanol and methyl hydroxy butanone. Samples also available.

338 Sodium Hydride Data. Physical properties, chemical properties, organic reactions, handling and storage procedures, suggested uses of sodium hydride. Technical bulletin from Callery Chemical Co.

(Continued on page 62)



DEVELOPMENTS OF THE MONTH (*Cont.*)

369 Teflon Clipper Seals. Chempac Teflon Clipper seals, now being marketed by Johns-Manville Corp., are claimed to assure positive sealing in the presence of and in contact with active solvents and corrosives. They are said to have successfully contained oils with varying aniline points and to have proved effective against such widely diverse fluids as rocket engine fuel, perchlorethylene, insecticides, and various refrigerants.

The body of the new seal is made entirely of Teflon and is encased in stainless steel or other corrosion-resistant alloy. The seal lip is actuated by a spring also made of stainless alloy.

A bulletin covering these and other sealing materials is available from the manufacturer. Circle number 369 on Data Post Card.

(Continued on page 62)

ANNOUNCING

CROLL-REYNOLDS'

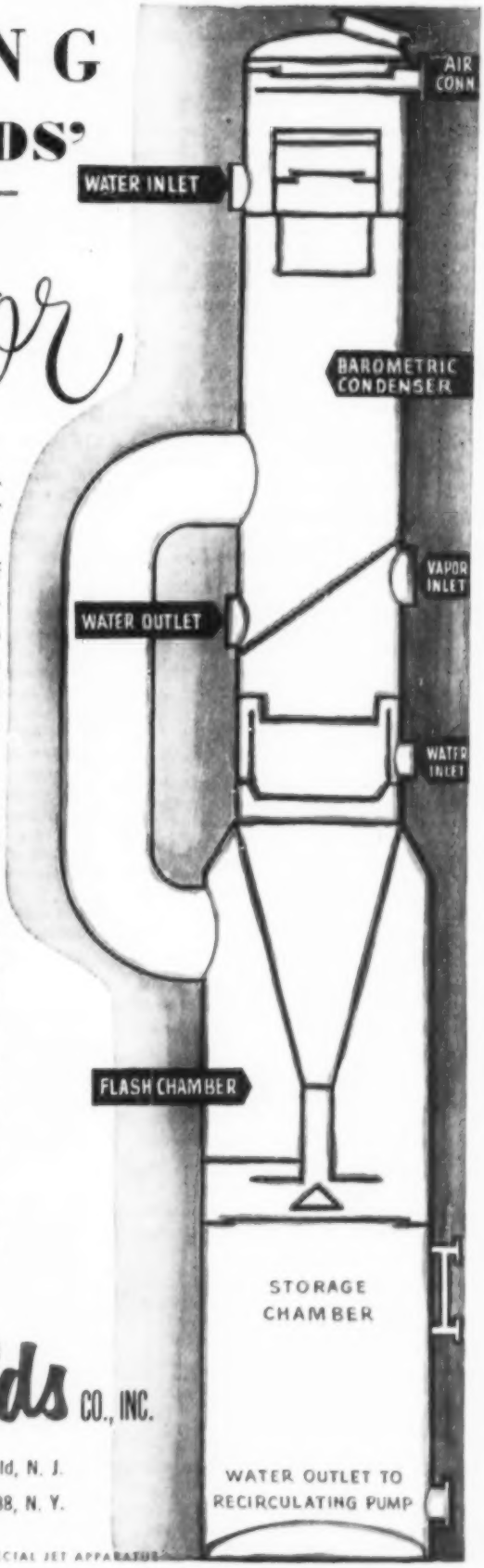
NEW Convactor

If you never heard of a CONVACTOR, do not be surprised. It is an entirely new design of special condensing tower which offers important advantages in some processes.

In the refining of edible oils it recovers fatty acids, most of which were formerly waste. It offers the additional advantage of totally eliminating stream pollution from this source or the expense of cleaning cooling towers which collect such deposits. It has similar application in fatty acid stills, some other types of distillation processes, dryers, and other large vacuum processing units.

The CONVACTOR is a combination of two condensers and a vacuum cooling chamber. One condenser is of conventional barometric design, the other a highly improved condenser working on the jet principle. The latter condenses the vapor from the process and discharges directly into the vacuum cooling compartment where the heat of condensation is immediately removed. The cold water is then recirculated through the same jet condenser. The flashed vapor from the cooling operation is condensed in a conventional barometric condenser using water from a river, cooling tower or other industrial source. Periodic blow-down or continuous bleed-off from the flash chamber permits recovery. Several large industrial installations have been made.

It is significant that this new contribution to vacuum equipment should come the year we are celebrating our Fortieth Anniversary.



CROLL-REYNOLDS

Croll-Reynolds CO., INC.

Main Office: 751 Central Avenue, Westfield, N. J.

New York Office: 17 John Street, N. Y. 38, N. Y.

CHILL VACTORS • STEAM JET EVACTORS • AQUA VACTORS • FUME SCRUBBERS • SPECIAL JET APPARATUS

MATERIALS

(Continued from page 60)

339 Polyethylene Film Report. Comprehensive report from U. S. Industrial Chemicals Co. titled "Heat Seal Characteristics of Polyethylene Film." Complete technical data, 40 charts.

373 Facts on Zirconium. Established and potential applications, corrosion data, physical properties, methods of fabrication. Booklet from Columbia-National Corp.

SERVICES

340 Engineering and Design Services. Allstates Design and Development Co. offers bulletin describing their services, including consulting, engineering, data processing, and electronic computer service.

341 Production Facilities. Foundry work, metal working, metal fabrication, and inspection services. Bulletin from Troy Engine & Machine Co.

342 Glycerine from Molasses. 8-page brochure from Scientific Design Co. describes new fermentation process. Flow sheets, feed stocks, products, including by-products (ethanol and acetaldehyde).

EQUIPMENT

343 Flexible Shaft Bulletin. Basic technical information and data on a complete line of flexible shafts for remote control, power drive, and coupling applications. 14 pages. S. S. White Industrial Division.

344 Vacuum Pumps, Gas Boosters, Air Motors. 16-page catalog from Lamson Bros., Inc. gives construction, dimensions, capacities, performance curves, installations.

345 Indicating and Controlling Meters. Bulletin from Hays Corp. gives technical details of their Veriflow meters and Veritrol controls.

346 Pump Brochure. Technical Data Brochure from Allen-Sherman-Hoff Pump Co. gives monographs and charts for selecting proper sizes and types of pumps.

347 Sintered Micron Filters. Hoke, Inc. offers complete range of filtering elements of either sintered bronze or 316 stainless steel. Additional technical data from manufacturer.

348 Case Histories on Meters. Bulletin from Neptune Meter Co. contains 12 pages of cost-saving metering information, including a number of actual case histories.

349 Process Equipment Fabrication. Processing and laboratory vessels, plate and frame filter presses, flush bottom valves, etc. Catalog from Star Tank & Filter Corp.

350 Heavy-Duty Rotary Pump. Few operating parts, operates at pressures to 500 lb./sq.in. In capacities to 25 gal./min. Technical data from Worthington Corp.

○ **CIRCLE** *your Data Service requests on the handy postcard on page 56 to*

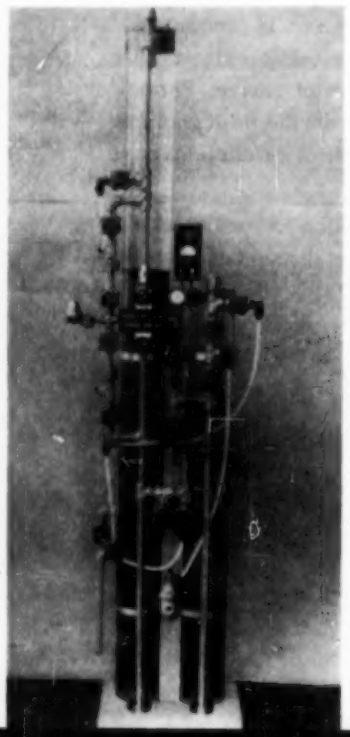
▶ **GET** *up-to-the-minute catalogs, data sheets and bulletins on new chemical products, processes and equipment.*

DEVELOPMENTS OF THE MONTH (Cont.)

370 Mono-Column Packaged Demineralizer. Penfield Manufacturing Co. offers a new mono-column demineralizer featuring cast acrylic columns for both carbon filter column and ion exchange column. The unit produces up to 100 gal./hr. of ultra-pure (less than ½ p.p.m.) tasteless and odor-free water. The Plexiglas columns enable the operator to see the action in both columns at all times. Exchange capacity of the resin charge is 18,000 grains. The unit's overall dimensions are 15 × 15 × 86 in. All piping, valves, screens, and eductors are 100% non-corrosive either red brass or Uscolite plastic construction.

Controls for fully automatic operation, including signalling when purity falls below a pre-set standard, or automatic accomplishment of a complete regeneration cycle on the turn of a single switch, are optional equipment. Further information on this and other packaged units in capacities up to 5,000 gal./hr. may be obtained by circling number 370 on Data Post Card.

(Continued on page 64)



351 Well Water Systems. Pumps, drilling, allied services and equipment. Booklets from Layne & Bowler, Inc., Memphis, Tenn.

352 Electromagnetic Flow Meters. Bulletin from Nuclear Corp. of America describes operating principles, gives specifications of their "Magnaflow" straight-thru flow meters.

353 Automatic Proportioning System. The Potter Ratiometer Model R11 can maintain pre-set flow ratios despite changing flow rates. Data sheet from Potter Aeronautical Corp.

354 Diaphragm Compressor. No contamination of gas. No lubricated moving parts in the gas side. Designed for handling corrosive, oxidizing, toxic, or inflammable gases. Data sheet from Pressure Products Industries, Inc.

355 PVC Pipe Fittings and Flanges. Bulletin from Albert Pipe Supply gives chemical properties, fabrication methods, processing advantages.

356 Lox Transporter. Liquid oxygen and nitrogen transporter with self-contained hydraulic unit for quick loading and unloading. In sizes to 2,500 gal. capacity. Details from Hofman Laboratories.

357 Graphite Heat Exchangers. 77 combinations of standard units cover range from 17.7 to 3,585 sq. ft. of heat transfer surface. Catalog section from National Carbon Co.

358 Magnetic Liquid Level Gauge. For use where dangerous fire or explosion hazards exist. For pressures to 2,500 lb./sq.in. at 600° F. Complete details from Jerguson Gage & Valve Co.

359 Micro Flow Rate Pump. Lapp Microflo Pulsafeeder Model LD is a duplex pump for pumping two liquids in equal volume or at any given ratio. Bulletin from Lapp Insulator Co.

360 Stainless Steel Filter Catalog. 12-page catalog with characteristics, application data, specifications on porous sintered stainless steel filters. Selection chart and filtration data tables. Cuno Engineering Corp.

361 Belt Weigher. Available in several sizes, covering range from 1 oz. to 100 lb. Speeds up to 15 discharges/min. Technical data from Glengarry Processes, Inc.

PRODUCTS ADVERTISED IN THIS ISSUE (Cont.)

(Continued from page 58)

59A Heat Exchangers. Patterson-Kelley exchangers assure accurate temperature control of processing and refrigeration. Technical literature.

61A Special Condensing Tower. The Convactor, developed by Croll-Reynolds Co., is an entirely new design of special condensing tower, offering important advantages in many chemical engineering processes.

63A Drying Service. Proctor & Schwartz, Inc. supervision ensures a dryer which will exactly fit your process needs.

(Continued on page 64)

a series about
PROCTOR SERVICES
for your new products

Mr. Albert G. Blank
Sales Manager
Process Industries Sales

No. 6: final design and fabrication of your dryer

Thus far we have discussed the many details which lead to a firm proposal for your Proctor dryer. Let us now consider more of the advantages of dealing with Proctor as your dryer goes into final design and fabrication. The complete job of product engineering begins with a thorough review of all process and test data. This is further insurance that your dryer will exactly fit your needs.

From here on, changes will be few. Opportunities for economy often arise as design progresses; deliveries of critical materials sometimes force changes; finalizing of dimensions may mean modifications. All such adjustments are always thoroughly discussed with the customer.

Early preparation for shop fabrication runs concurrently with final design. Bills of materials are prepared, stores are checked, long delivery material is ordered, shop schedules are prepared, even the details of transportation for the finished dryer are worked out in advance.

As a result, when actual fabrication begins, there are no delays. Work moves smoothly and quickly through the shop, guided by experienced supervisors and built by expert craftsmen, using the finest tools and equipment.

Through the efficiency of the Proctor staff, the first portion of the guaranteed performance is achieved—delivery on schedule.

There *are* real advantages in dealing with Proctor.

Proctor

PROCTOR & SCHWARTZ, INC.
PHILADELPHIA 20 PA.

PRODUCTS ADVERTISED IN THIS ISSUE (*Cont.*)

(Continued from page 62)

65A Automatic Classifier Operation. Latest development in wet cyclone classifiers is an automatic control arrangement that does not require instrumentation. Information from Dorr-Oliver, Stamford, Conn.

67A Heat Exchangers. M. W. Kellogg engineers and fabricates heat exchangers to special as well as to standard specifications.

69A Design and Construction Services. Project analysis, process development and design, economic studies, engineering, procurement construction for the metallurgical, chemical, petrochemical, and oil refining industries. Catalytic Construction Co.

70L Filter Press Catalog. Specifications, other technical data on complete line of filter presses made by D. R. Sperry & Co.

71A Isotherm Compressors. For large volumes of oil-free air—5,000 std. cu. ft./min. and up, at pressures from 100 to 300 lb./sq. in. abs. Technical details from Brown Boveri Corp.

72L Thermo-Compression Process. Provides economy and efficiency in evaporation processes. Information available from Elliot Co.

73A Pilot Plant Heat Transfer Units. High rate of heat transfer, pressures to 500 lb./sq.in., temperatures to 750° F. Bulletin from Girdler Co. describes the Votator unit for laboratory or pilot plant.

75A Design and Construction Services. Brochure from Southwestern Engineering Co. describes its facilities for design and erection of refineries or petrochemical plants.

76L Wire Cloth Catalog. Describes line of industrial wire cloth in bulk or fabricated parts. Nine weaves, from the finest to the coarsest, in any metal or alloy. Cambridge Wire Cloth Co.

77A Compacting Process. Precise control of particle size, density, and solubility factors assured with the Allis-Chalmers compacting process. Bulletin.

78L Air-conditioning Systems. Bulletins from Niagara Blower Co. give details of its controlled-humidity method using Hygrol moisture absorbent liquid.

79A Engineering Services. Every project of the Badger Manufacturing Co. is headed from start to finish by a "key man" who is always a Badger principal.

80L Free Tantalum Test Kit. Corrosion test kit, available without charge to research technicians, contains both tantalum sheet and wire. Fansteel Metallurgical Corp., Chemical Equipment Division.

81A Filter Equipment. Consulting services available from Eimco Corp. on all types of filter equipment and accessories.

83A Data on Molecular Sieve Adsorbents. Technical literature from Linde Co. describes properties and performance characteristics of Molecular Sieve adsorbents.

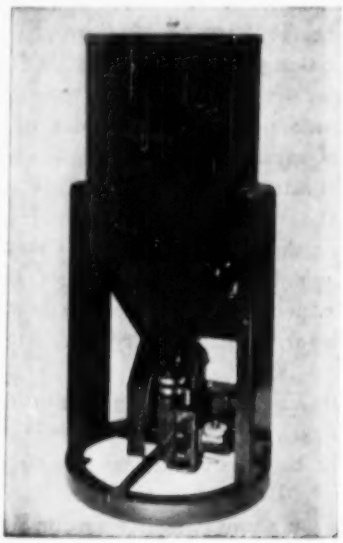
84TL Scale Feeder Bulletin. Describes the Merchen scale feeder, available with feed rates from 3 to 3,000 lb./min. Wallace & Tiernan, Inc.

84BL Trichloromelamine. An effective yet stable germicide with minimum of 89% available chlorine. Bulletin and samples available from Wallace & Tiernan, Inc.

85A Corrosion-Resistant Valves. Bronze, acid-resisting bronze, Ni-resist, stainless steel, nickel, Monel, Hastelloy, Durimet, rubber-lined. Details from DeZurik Corp.

DEVELOPMENTS OF THE MONTH (*Cont.*)

371 New Feeder for Concentrated Slurries. A complete packaged unit offered by Wallace & Tiernan consists of a slurry reservoir, pumping unit, integral air compressor for slurry agitation, and an electric motor with belt drive, all mounted in a free-standing pedestal.



The concentrated slurry flows from the reservoir into a metering chamber. The metering chamber is connected directly to the reservoir, eliminating suction lines which might be subject to clogging. Flushing liquid under pressure flows through the feed chamber, dilutes the slurry, and flushes it to the point of application. Feed rate is from 0.33 to 1.66 gal. of concentrat d slurry/hr.

The unit will handle slurries against positive pressures up to 40 lb./sq.in. and negative pressures down to 20 in. Hg. Air agitation in the 30 gal. capacity reservoir eliminates mechanical mixers. For technical literature on the new slurry feeder, circle number 371 on Data Post Card.

(Continued on page 66)

86L Filter Papers. Eaton-Dikeman Co. will furnish samples for test runs without obligation.

87A Expansion Joints. Corruflex expansion joints are packless, require no maintenance. Sizes 3 to 54 in., temperatures to 1,600° F., pressures to 300 lb./sq.in. Adsco Division, Yuba Consolidated Industries, Inc.

88L Heating and Cooling Coils. Aerofin Smooth-Fin coils offer greater heat transfer, lower airway resistance. Bulletin from Aerofin Corp.

89A Glassed-Steel Processing Equipment. Bulletin from Pfaudler Co. gives detailed instructions for the installation of glassed-steel reactors.

91A Data on Special Purpose Steels. 44-page booklet from Crucible Steel Co. of America: "Making the Most of Stainless Steels in the Chemical Process Industries."

92L Closed-Circuit Drying Systems. Turbo-Dryer closed-circuit systems are available in range of sizes from packaged pilot plants to units with evaporative capacities in excess of 20,000 lb./hr. Wyssmont Co., Inc.

93R Data on Viscometers. Bulletin from Brookfield Enginering Laboratories gives technical details on the Brookfield 8-speed viscometer.

94L Silicone Coatings. Midland Industrial Finishes Co. offers data on Sicon silicone coatings for high temperature resistance.

95R Fully-Automated Centrifugal. The Fletcher Tornado, bottom-discharge, tri-point centrifugal, assures fully-automatic, 24-hour production. Information from Fletcher Works, Inc.

96L Laboratory Reaction Flasks. All heads interchangeable with all bottoms, in capacities from 1 to 72 liters. Ace Glass, Inc.

97A Nitrogen Generator Booklet. Describes complete nitrogen generation systems which can use wide range of fuels such as natural gas, LPG, hydrogen, and light fuel oils. Gas Atmospheres, Inc.

98L Tray Dryers. From one tray to dozens, from small table or lab models to huge, multi-stacked, multi-tray jobs. Details from C. G. Sargent's Sons Corp.

99A Carbon and Graphite Products. Technical data from National Carbon Co. on carbon and graphite structures, "Karbate" heat transfer systems, from U.S. Stoneware on "Intalox" saddle packing now available in carbon.

100L Water Purification Equipment. Bulletin from Barnstead Still & Demineralizer Co. describes equipment for the production of purest water by demineralization, distillation, and submicron filtration.

100BR Miniature Gasket Thermocouples. Choice of three temperature ranges covers minus 300 to plus 1,200° F. Calibrations include either copper-constantan or iron-constantan. Bulletin from Thermo Electric Co.

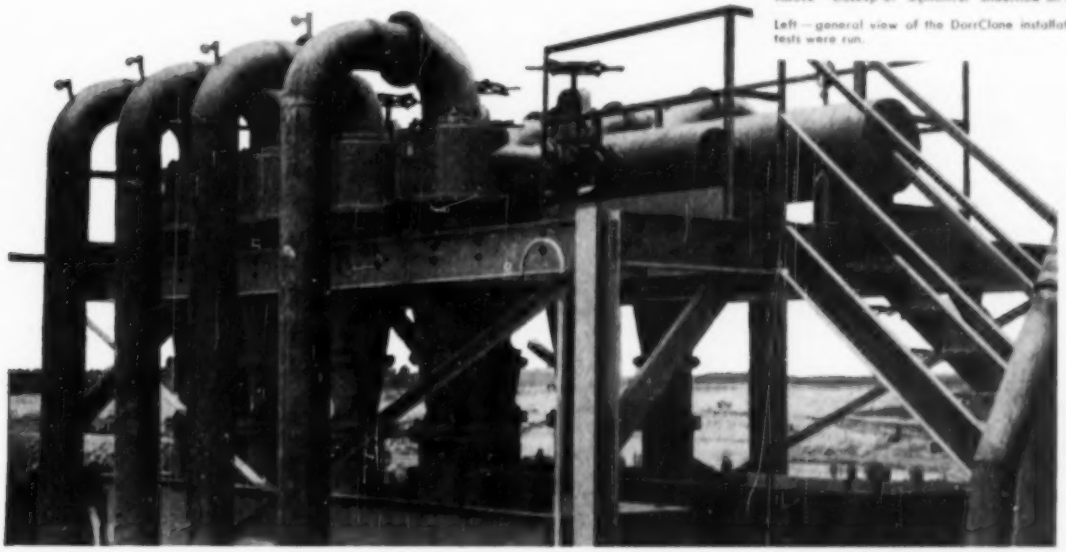
(Continued on page 66)

NOW... Automatic Control of DorrClone Classifier Operation . . .

Without Instrumentation!

Above — closeup of "Siphontrol" underflow on one unit.

Left — general view of the DorrClone installation on which tests were run.



Latest development in wet cyclone classifiers is an automatic control arrangement that does not require instrumentation. Named the "Siphontrol" underflow control, this new device maintains a reasonably constant underflow density from varying feed solids. Basically it consists of a tail piece extending below the apex valve of the cyclone discharging into a "Saucer" clamped on to this tail piece. The overflow pipe discharge is also submerged using either a saucer device or manifold.

Here are some typical operating results from DorrClone Classifiers in the field equipped with Saucer controls. These units are desliming phosphate rock at one of the mines in the Florida Pebble Phosphate Field. Successive tests were made at five-day intervals. Note the uniformity of separation despite the wide variation in feed composition.

Equipment — Seven 24" dia. DorrClone Classifiers **Control** — "Saucer" Underflow Density Controller

Test No.	1			2			3			4		
	Feed	O'flow	U'flow	Feed	O'flow	U'flow	Feed	O'flow	U'flow	Feed	O'flow	U'flow
Total TPH Solids	601.2	463.4	143.9	325.7	212.1	136.7	302.7	160.4	122.6	785.3	648.7	165.0
TPH + 150 mesh	442.9	449.0	13.5	204.2	202.3	7.0	211.6	148.4	8.0	674.9	615.7	21.5
TPH — 150 mesh	158.3	144.0	130.4	121.5	9.8	129.7	91.1	12.0	114.6	160.4	33.0	143.5
Efficiency												
+150 mesh recovered		97.1%			96.7%			94.9%			96.6%	
—150 mesh eliminated		90.1%			93.0%			90.5%			81.3%	

Tonnages are timed samples and are well within accuracy of method of measurement.

For more information on this new development in wet cyclone techniques, write Dorr-Oliver Inc., Stamford, Connecticut

DORR-OLIVER
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STAMFORD • CONNECTICUT • U. S. A.

DorrClone and Siphontrol are trade marks of Dorr-Oliver Inc.

PRODUCTS ADVERTISED IN THIS ISSUE (Cont.)

(Continued from page 64)

101BL Metallic Raschig Rings. Available in all workable metals. Complete information from Metallo Gasket Co.

101R Nickel Alloy Fabrication. Design, development, fabrication of tanks, piping, pressure vessels, bubble towers, special equipment. Misco Fabricators, Inc.

103A Sulfur. Production of chemicals used for fluoridation of drinking water requires use of a sulfur compound—sulfuric acid. Texas Gulf Sulphur Co.

DEVELOPMENTS OF THE MONTH (Cont.)

372 Pilot Plant Dryer. Designed to fill the gap between the laboratory and the production line, a new dryer developed by C. G. Sargent's Sons Corp. also has sufficient capacity for seasonal or auxiliary production work. It can be made with any number of sections and is so designed that additional sections, completely equipped with fan, motor, heating coils, and conveyor, may be installed easily and quickly on location. Sections may be temperature and moisture-zoned separately. The unit is available in aluminum, stainless steel, or other materials as required. It is made in two sizes, the smallest of which is only 4 ft. high and 3 ft. 9 in. wide. Technical details can be obtained by circling number 372 on Data Post Card.

104L Vacuum Dryer Bulletin. Folder from Paul O. Abbe, Inc. describes technical details of the Rota-Cone vacuum dryer.

105A Water-Lubricated Turbine Pump. Technical details from Fairbanks-Morse on new F-M Pomona pump for raw water supply, air conditioning, refrigeration, cooling towers, sump pumping, dewatering.

106L pH Control Equipment. Free handbook from W. A. Taylor and Co. "Modern pH and Chlorine Control."

106BR Heat Exchange and Process Equipment. Condensers, evaporators, kettles, mixers, agitators, reactors, pressure vessels, heat exchangers. Manning & Lewis Engineering Co.

107BL Heatless Desiccant Air Dryers. Complete line of electric or steam regeneration dryers—automatic, semi-automatic, or manual operation. Operating pressures to 5,000 lb./sq. in. Information from Kahn and Co.

107R Fused Silica Laboratory Ware. Chemical purity, high resistance to heat shock, good electrical resistivity. Bulletin from Thermal American Fused Quartz Co. describes line of Vitreosil ware.

108L Self-Cleaning Heat Exchanger. Eliminates need to stop processing for cleaning purposes. Bulletin on Paracoil exchangers from Davis Engineering Corp.

109A Dryers, Coolers, Calciners, Kilns. Individual units or complete systems including all materials handling, processing, and storage facilities. Bulletin from C. O. Bartlett & Snow Co.

112A Clarifier Bulletin. Brochure from Centrico, Inc. describes technical advantages of the KG clarifier with six-chamber bowl design.

116BL Chemical Process Control Analyzers. Improved analyzers for air, nitrogen, and argon purification, chlorine, hydrogen, and ammonia production. Thermco Laboratories.

116BR All-Plastic Gate Valve. Combines no-pressure drop construction of gate valve with throttling flow-control feature of globe valve. Catalog from Vanton Pump and Equipment Corp.

117B Electric Bulk Materials Distributor. New H&S electric distributor can be fitted with 5 to 20 openings. Hayes & Stolz Industrial Manufacturing Co.

119A Fluid-Jet Grinding Equipment. Sturtevant Micronizers are available in capacities from ½ lb./hr. to 4,000 lb./hr. Technical details from Sturtevant Mill Co.

120L Centrifugally-Cast Pipe. Alloyed to resist corrosion and high temperature. Data from Duraloy Co. on Duraspun centrifugally-cast pipe.

121A Engineering and Construction Services. A single responsibility contract can be the key to a successful construction project. J. F. Pritchard & Co.

122BL Welded Aluminum Tanks. For storage, pressure vessels, and processing equipment, built to ASME Code specifications. R. D. Cole Manufacturing Co.

122BR Spray Nozzle Catalog. Reference data on thousands of standard and special spray nozzles for every type of spraying. Spraying Systems Co.

123A Technical Bulletin on Filteraids. Brochure on Dicalite filteraids discusses principles of filtration, has many charts and diagrams. Dicalite Dept., Great Lakes Carbon Corp.

124TL Tower Packings. Raschig rings, single-partition rings, cross-partition rings, Berl saddles. Uniform quality, high chemical purity, iron-free, great mechanical strength. Knox Porcelain Corp.

124BL Faced Mechanical Seals. New facing material available on the Dura Seal combines low-friction benefits of ceramic materials with strength and resistance of alloy steels. Bulletin from Durametallic Corp.

125TL Pipe Bends and Welded Assemblies. Fabricated from any ferrous or nonferrous pipe or tube in size range from ½ to 8 in. iron pipe size. Engineering data book from Rempe Co.

125TR Gear Pump Bulletin. Brochure from Schutte and Koerting Co. describes line of SK gear pumps and engineering services.

125BR Pyrex Sight Glasses. Squares, rectangles, or odd shapes available in 8 thicknesses, sizes up to 24 by 60 in. Bulletin from Swift Glass Division, Swift Lubricator Co.

129TR Heating Coils. Bulletin from Dean Thermo-Panel Coil Division, Dean Products, Inc. gives technical information, design data, and prices on the Dean Thermo-Panel Coil.

O **CIRCLE** *your Data Service requests on the handy postcard on page 56 to*

▶ **GET** *up-to-the-minute catalogs, data sheets and bulletins on new chemical products, processes and equipment.*

129BR Spray Drying Test Facilities. Test facilities are available now at low rates at Bowen Engineering, Inc. Illustrated booklet.

IBC Engineering and Construction Services. Ralph M. Parsons Co. invites inquiries on design, procurement, construction, or operation of chemical process facilities.

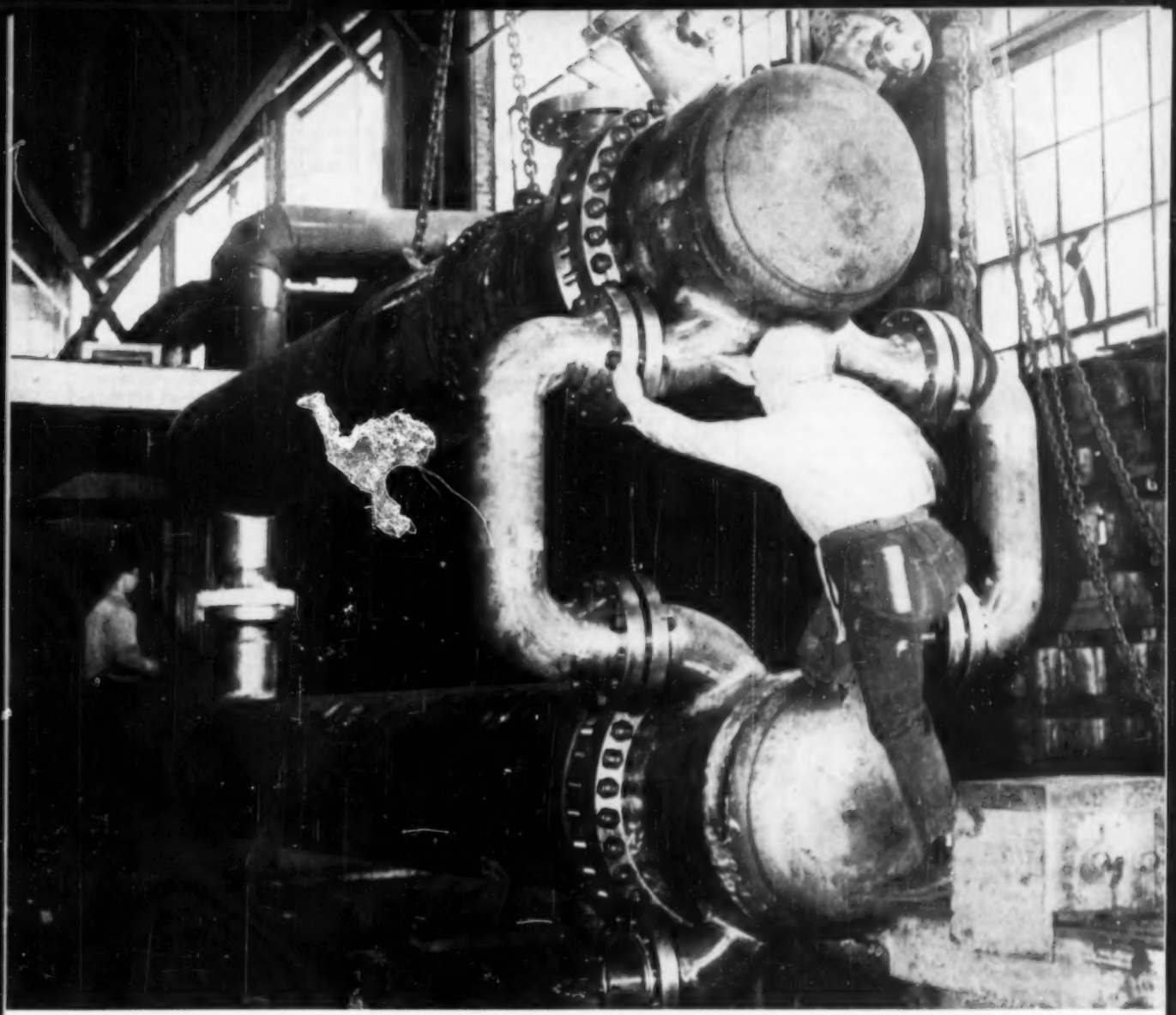
OBC Mixing Bulletins. Several bulletins with latest mixing information and full description of Lightnin Mixers available from Mixing Equipment Co.

RETRACTABLE FILTER

(Continued from page 55)

Unique feature of the design is the quick opening head operated by a hydraulic pump on the operator's platform. The shell is retracted by means of an air motor and the cake washed off with a high-pressure hose. A quick-locking nozzle facilitates replacement of filter cloth on the leaves.

Technical literature is available from the manufacturer. Circle number 363 on Data Post Card.



"Special" in Every Way

Made entirely from Type 321 stainless steel, this unusual heat exchanger demonstrates The M. W. Kellogg Company's ability to engineer and fabricate such equipment to special as well as standard specifications. In this case, special welding procedures were developed, as well as special methods of seal-welding tubes to tube sheets; special machining of the tube sheet was required for each tube; and special techniques were employed for testing. Special in every way, this unit is scheduled for special service in an English oil refinery.

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SALINE WATER CONVERSION

Washington International Symposium on Saline Water Conversion November 4-6 reviewed progress on four basic processes in various countries.

Joseph L. Gillman, Jr.

Reports from a number of countries doing research on demineralization of sea water were presented at The International Symposium on Saline Water Conversion meeting in Washington, D. C. November 4-6 under the combined auspices of the Office of Saline Water, U. S. Department of the Interior, and the National Academy of Sciences-National Research Council. In addition to these progress reports, many other papers on this important subject were presented.

Saline water research is being carried out in various countries:

In *France*, with a fractionized freezing method by which drinking water has been produced from sea and brackish water; in *North Africa* work has been directed toward distillation by solar energy; in the *Netherlands* the main effort has been centered on electrodialysis, which in a standard model is producing 36 cu.m./day from sea or brackish water; in *Britain* the Admiralty is studying multiple distillation and thermo-compression demineralization; in *South Africa* extensive work on electrodialysis and the perfection of a satisfactory membrane is reported; in *Australia* research on solar energy is being done, with a special apparatus for the Antarctic being reported; *Italy* is working on problems of solar distillation; in *Israel* research on fractionized freezing is being kept secret, but electrodialysis has led to some membrane research; *Japan's* efforts are being spurred by her need for salt and this has led to work with the freezing process.

U. S. Progress Outstanding

Except for military uses, the primary objective of saline water conversion research in the U.S. is the reduction in cost of converted water. Because of the range of present water costs—up to a maximum of $2 or more/thous. gal. for industrial water, 35¢ for municipal water, and 12¢ for irrigation water—there is a field of immediate potential uses for converted water for industrial supplies at from $600 down to $100/acre ft.

The most important outcome of the whole OSW program may well be the real breakthrough conceived by scientists who started work on the desalination problem because of OSW stimulus. This has been accomplished on a very modest OSW budget.

Pilot plant facilities have been established at Harbor Island, North Carolina in conjunction with the Office of Saline Water (through courtesy of Int. Nickel Co.) to investigate problems in the design of full-scale conversion plants. Three companies doing active research are located in the vicinity. W. L. Badger & Associates, Ann Arbor, Mich., with OSW assistance has a multiple-effect distillation unit and with Whiting Corp., Harvey, Ill., is studying scale and corrosion prevention. Griscom-Russell Co., Massillon, Ohio, under contract with OSW, has been working for about a year on design and feasibility studies of single-stage, low-temperature flash distillation using the internal energy of warm saline water. Kenneth Hickman of Rochester, N. Y. has designed a centrifugal vapor-compression still which is being manufactured by Badger Mfg. Co., Cambridge, Mass. and is undergoing an extended test run at Harbor Island. OSW has sponsored further research with the emphasis on developing solar distillation processes of non-focusing types, and of simple design, based on the investigations of George O. G. Löf of Denver, Dr. Maria Telkes of N.Y.U., DuPont, and Bjorksten Research Labs., Madison, Wisc. Some of the tests have been temporarily set aside for lack of funds.

Performance data for solar stills is based mainly on small units only a few feet in area, therefore projection of this information to large capacity plants can not be made with confidence. Even with the exceptionally simple and cheap construction possible for this type of still, water production costs have been computed ranging from 70¢-$1.25/1,000 gal. Though many cost estimates place solar distilled water at a higher price than other processes, local conditions might nevertheless favor this method where others might be impractical. Compared to this, estimated figures for the other processes mentioned above are: 50-70¢/1,000 gal. for the large size multiple-effect still; 65¢-$1.15/1,000 gal. for flash distillation; 96¢/1,000 gal. for rotary vapor-compression method. The OSW goal is in the neighborhood of 35¢/1,000 gal. for municipal water.

THE HEART OF THE MATTER

- **The U.S. leads the free world in saline water conversion research.**
- **W. L. Badger & Associates, consulting engineers, Ann Arbor, Michigan, appear to be close to an economical solution to the problem: estimate—water at 20-40¢/1,000 gal. Source of heat: low pressure exhaust steam from a power plant. Equipment: all conventional chemical engineering equipment, mostly multiple vertical tube evaporators. Material: practically all carbon steel with some exceptions. Technique: standard chemical engineering multiple-effect evaporation.**
- **Future: Perhaps the largest market for chemical engineering equipment that has ever been developed.**

Some Problems

Actual conversion problems are many and varied.

Salt water differs from fresh water in many respects. Thermodynamically, the most important factor is the free energy of dilution—the free energy, that is dissipated when a river flows into the ocean is roughly equivalent to the loss of potential energy in a waterfall 1,000 ft. high. To separate the water from the salt solution, the absolute minimum work that must be done is equivalent to pumping the water back against the thousand foot head. Change of phase in water solutions involves the transfer of large quantities of heat. For efficiency this can be done in a low temperature gradient, requires massive equipment and means great expense for installation and maintenance because of corrosion.

The primary problem of the multiple-effect still is scale formation. Acid-injection with closely controlled *p*H, or sludge recirculation (seeding) are both feasible answers. Badger Associates claims the success of the latter method in other similar processes by recirculating crystals in suspension; salts then deposit on existing crystals rather than on the metal surfaces.

Recommendations for Future

The Saline Water Symposium centered around the four basic practicable ways of saline water conversion: distillation, membrane, solar, and freezing processes. Recommendations concerning these four fundamental approaches were made, all hinging on adequate funds from Congress.

- *Symposium Distillation Committee* recommended immediate initiation of a long-term investigation of factors affecting the mechanism of scale formation and any related effects of corrosion; a more intensive study of methods of improving heat transfer; and a more intensive study of the feasibility and cost of flash distilla-

(*Continued on page 70*)

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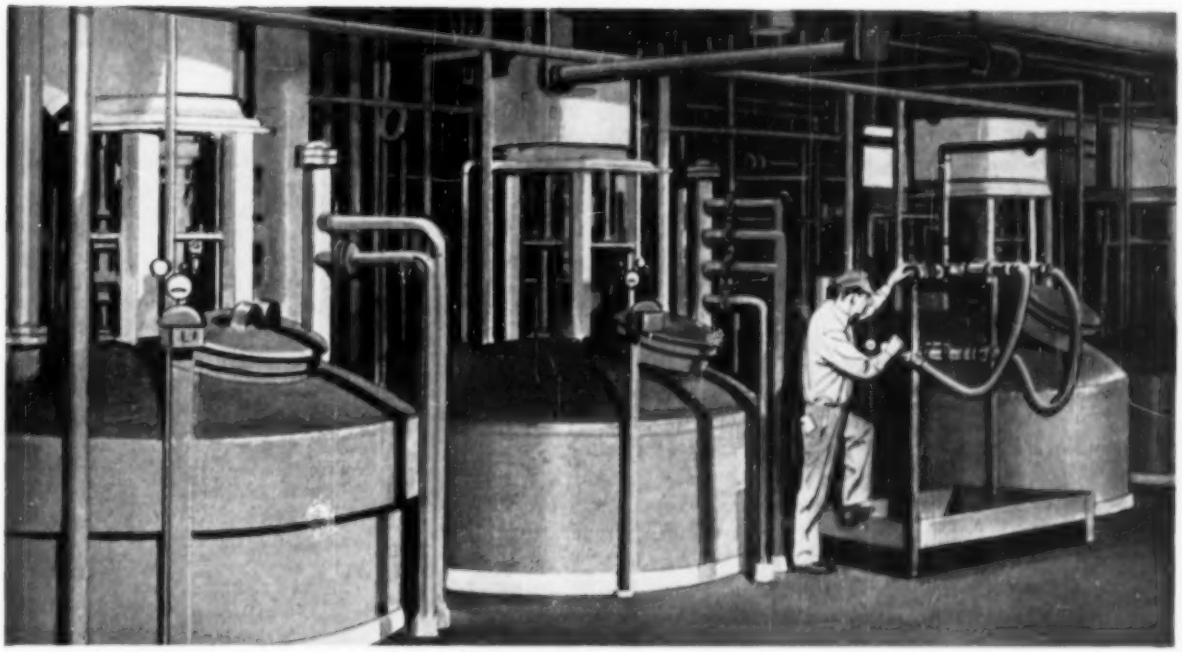

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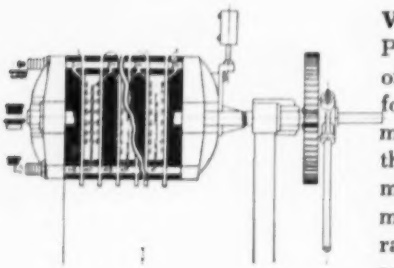

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SALINE WATER

(Continued from page 68)

tion, particularly at low temperature levels, but also in higher pressure multi-stage units.

A cost study of the most promising distillation schemes would cost about $250,000.

• *The Membrane Committee* felt that since the economic future of electrodialysis is believed to be in the treatment of brackish waters rather than sea water, a test station at a seashore location would not be of immediate interest. The desirability, however, of establishing a *large* experimental test station in a brackish water area was discussed. It was agreed that basic research and pilot tests of electro-dialysis units should be continued (pilot tests refers to units containing several membrane stacks of regular size, e.g. the size of "Ionics" unit stacks), but the committee was divided on the desirability of a full-scale demonstration plant.

• *The Solar Committee* felt that the outlook should be broadened to treat the subject as solar *demineralization* rather than solar *distillation*; that the uncovering of information on the use of solar energy for the demineralization of water and the proving of that information by pilot plant data are more important than the consideration of what use areas will be affected; that operating solar demineralization plants are difficult to justify in continental U.S.A. at the present stage of knowledge and price of fuel, but that full-scale plants should be erected in selected parts of the world to obtain usable operating data and as a good-will gesture to help the underprivileged countries and regain the initiative for the Western Powers.

• *The Freezing Committee* on desalting water by the freezing process recommended further studies of the scientific feasibility of increasing ice crystal size, especially as related to counterflow operations; investigation of the freezing mechanism when frozen droplets are produced from saline water; work on the mechanism of heat transfer in solution with dissolved solids; and the continuation of zone freezing experiments in desalting. Specific recommendations pertaining to economic feasibility included the design and construction of a Carrier-type desalting pilot plant; the enlargement of the research program on the isobutane freezing unit (including testing in the laboratory); economic study of a combination freezer desalting power plant unit; and creation of a committee on standards of materials to be compared for use in all saline water equipment at different capacity ranges.

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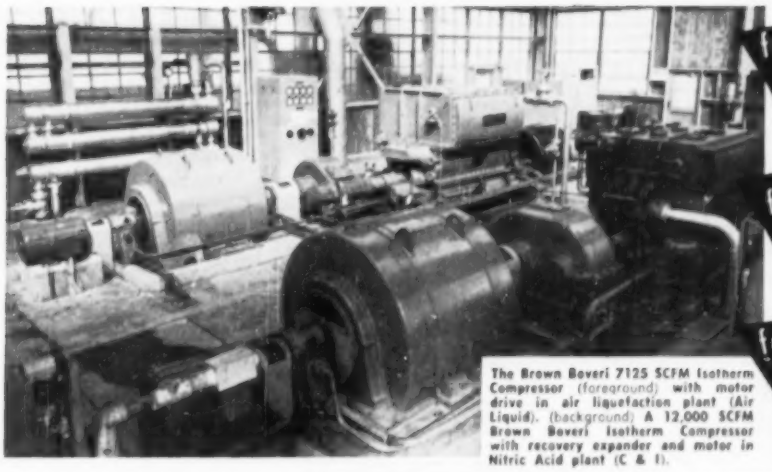

The Brown Boveri 7125 SCFM Isotherm Compressor (foreground) with motor drive in air liquefaction plant (Air Liquid). (background) A 12,000 SCFM Brown Boveri Isotherm Compressor with recovery expander and motor in Nitric Acid plant (C & I).

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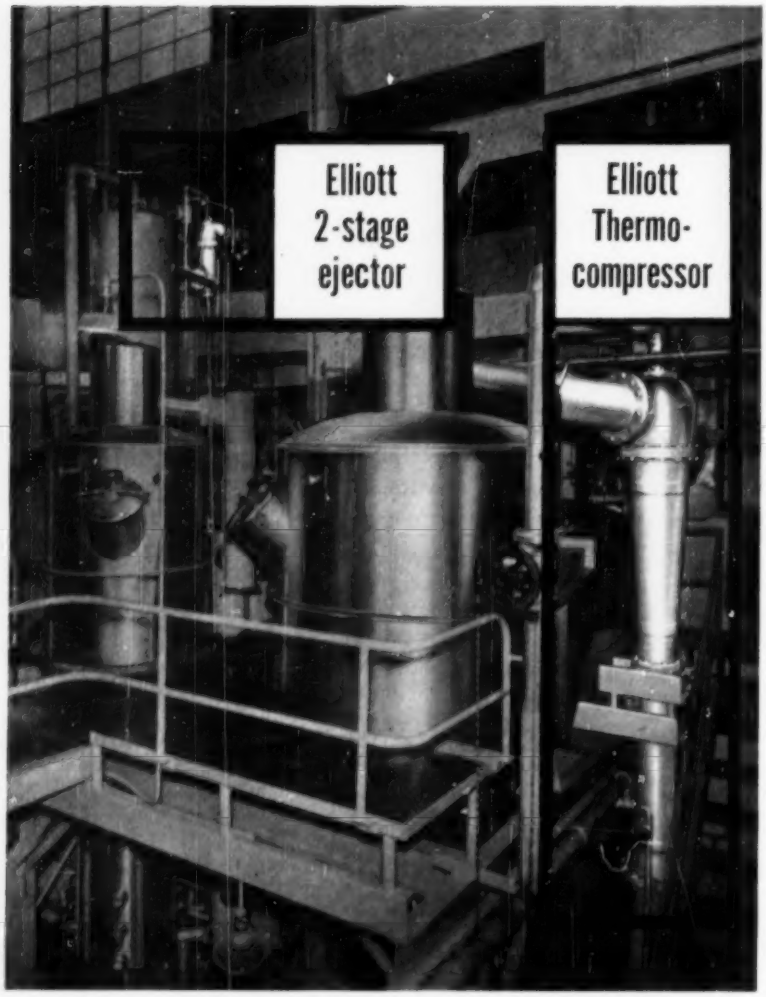

Thermo-compression provides ECONOMY and EFFICIENCY in evaporation process

In the installation shown above may be seen (right) a large Elliott thermo-compressor in vertical position, and (left) an Elliott two-stage ejector serving a condenser.

Thermo-compression as applied to evaporators is an arrangement wherein vapors discharged from an evaporator effect are captured and compressed to higher pressure and temperature for re-use on the hot side of the heating surface.

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The experience of the Elliott engineering staff is available to assist in investigating applications for this thermo-compression process.

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MCA MEETING

(Continued from page 52)

can do or say by itself," said Frederick Bowes, Jr., public relations and advertising V.P. at Pitney-Bowes, speaking on the same panel as McCarty.

Advertising and New Products

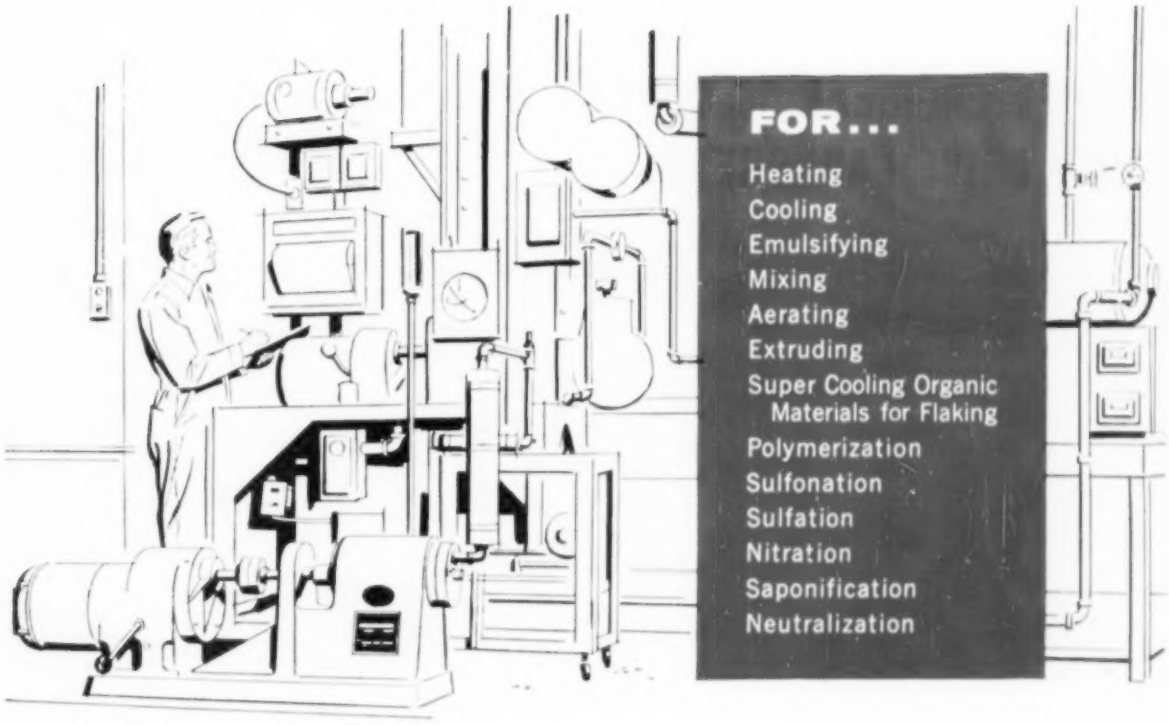
Chemical advertising came in for a share of attention. Measurement methods are among the new developments in chemical advertising being considered by some of the larger companies, notably DuPont, which has added Ph.D. psychologists to its staff for this purpose. This trend, said W. E. Gordon of DuPont, "leads us to the fond hope that, within the next few years, we may be able to apply the same yardsticks in measuring advertising efficiency that we now apply to manufacturing and engineering efforts."

"Decisions made many years ago have a potent effect on today's profit levels," declared John Field (Union Carbide), moderator of the panel on Management of New Products. "Similarly," he continued, "it is true that, in a well-established company, there may be little that management can do to affect today's operating results, but management can do a great deal to affect the results five to ten years in the future." Against the backdrop of Field's basic statement of the problem, speakers from Food Machinery & Chemical, Minnesota Mining and Manufacturing, DuPont, and Pfizer discussed aspects of the questions involved in the development and introduction of new products.

Basic Optimism

"The over-all chemical industry will follow its traditional pattern of continued growth at a rate somewhat higher than all other industry," said Donald Ballman, Dow Chemical's director of sales, panelist at the session on The Economic Climate: Outlook for the Chemical Industry. However, cautioned Ballman, "there are warning signs that, unless profitability can be maintained, continued high expenditures for research and development cannot be sustained."

A basic optimism was also the keynote sounded by Dexter Keezer, McGraw-Hill economist. Said Keezer, "The tremors at the lower end of Manhattan Island to the contrary notwithstanding, I expect the year 1958 to be entered in the record books as a good year for American business."



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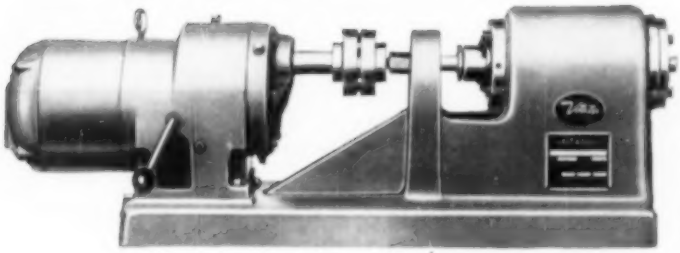

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UNITED ENGINEERING CENTER FUND DRIVE LAUNCHED

The new $10,000,000 United Engineering Center to be erected on United Nations Plaza, New York City, will be ready for occupancy in the fall of 1960. The building will be a 20-story tower superimposed on lower structures with appropriate landscaping. This United Engineering Center (U.E.C.) will serve as headquarters for the five Founder Engineer Societies of 179,000 members, the Associated Societies with more than 66,000 members, and the 36,000 student member Societies.

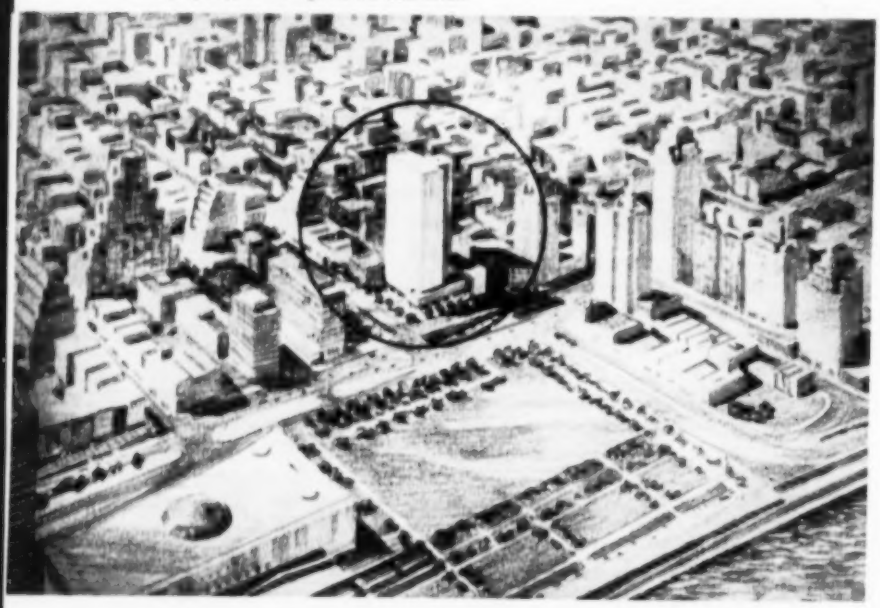
The new Center will contain the Engineering Societies Library, space for interpretive exhibitions of new engineering developments, meeting rooms, plus the vital space needed to serve a growing membership which has leaped from about 16,000 in 1907 to more than 280,000 in the Founder Societies and Associates today. The new building will have adequate facilities for all five participating societies as well as for 15 other organizations who wish to be associated with the new Center. Space plans call for a building of about 250,000 square feet.

Kickoff for Fund Drive

Thursday, November 21 was the milestone day for the United Engineering Building Fund. At an afternoon Waldorf Astoria press conference, Mervin J. Kelly, president of Bell Telephone Laboratories and chairman of the industrial division of the campaign, made the first announcement of plans for the new Center. Later in the evening, Dr. Kelly's announcement was a feature of the formal launching of the fund drive at a dinner meeting at the Waldorf Astoria attended by Hon. Herbert Hoover, honorary chairman of the campaign; Alfred P. Sloan, Jr., honorary vice-chairman; and more than 100 leading industrialists and educators from all parts of the country.

The industry campaign which Dr. Kelly heads has a goal of $5,000,000. Members of the various engineering societies are expected to contribute $3,000,000. This money, together with $2,000,000 which is available in the assets of United Engineering Trustees, Inc., (U.E.T.), is expected to meet the $10,000,000 cost of the new Center.

Artist's bird's-eye view of the new Center's site points up its advantageous location—across the street from the United Nations in midtown New York City. Park area in foreground is part of U.N. property; lower right is the East River.



TIMELY PROJECT, TIMELY REMARKS

Leading speakers at the November 21 Waldorf Astoria banquet which launched the fund-raising drive included Hon. Herbert Hoover; Mervin J. Kelly; James R. Killian, president of M.I.T.; Donald Quarles, Deputy Secy. of Defense; Alfred P. Sloan, Jr., General Motors; Ralph Cordiner, president of General Electric; and Walter Barrett, president of U.E.T.

Mr. Hoover underscored the crucial need for the new Engineering Center by comparing the plight of technical education in the U.S. with that on the Russian scene. The Russians are producing two or three times as many scientists and engineers as is the U.S.A. Mr. Hoover said further, that fewer than 12 per cent of our students are taught the elements of algebra and geometry. Less than 7 per cent study elementary chemistry, and less than 5 per cent experience elementary physics. In the face of the Soviet boast that the next war will be fought in the classroom, these statistics should be a warning.

Dr. Killian stressed the role of the engineer in modern society: "The engineer's education in my judgment must contain a larger content of basic science; he must have the breadth of education and understanding in fields other than his own technical specialty . . . so that he can contribute to the policy making of this country."

Donald Quarles reminded the audience of the stupendous progress in engineering during the last few years: "We learned in 1954-55 of the Russian's Bisons and Bears and the very excellent technology that these two intercontinental bombers represented . . . we (therefore) really did not have to be told very much about the Sputnik they launched recently. Our new U.E.C. building (a dream in 1948) is a *must* today; it will be a measure of America's ability to meet Russian competition."

Mr. Cordiner emphasized the need for funds for the U.E.C. and Mr. Sloan stressed the danger that lies in not planning and building "big enough" for the future.

Dr. Kelly pleasantly surprised the group of more than 100 presidents and chairmen of the boards of America's largest businesses and industries present at the Waldorf by reporting a pre-kickoff total of more than $1,000,000.

The new Center will be owned by United Engineering Trustees, Inc., (U.E.T.), a nonprofit corporation made up of representatives of the Founder Engineering Societies (A.S.C.E., A.I.M.E., A.S.M.E., A.I.E.E., and A.I.Ch.E.). The U.E.T. have appointed Shreve, Lamb & Harmon Associates as architects for the new U.E.C. building. Jaros, Baum and Bolles have been named mechanical engineers, and Seelye, Stevenson, Value, and Knecht will be the structural engineers.

(Continued on page 76)

He Builds with SWECO

When this oil man needed a new refinery he faced a basic question: *How to get the best design and construction at lowest capital investment?* SWECO's answer made him a life-long client.

To build a new refinery for his supply of crude, he investigated many engineering and construction companies. One, he found, was just the right size: Not so big that his medium-size installation would get lost behind vast projects. But big enough to provide complete service. The picture was perfect: personal attention from a seasoned staff.

He investigated SWECO

SWECO engineering teams had designed and built complete refineries and refinery additions all over the world. They were licensed to engineer and construct plants for most modern refining processes. SWECO jobs, he found, were brought in on-target – regardless of location, weather, untrained labor or earth-girdling supply lines. And SWECO's reputation in the design and manufacture of petroleum processing equipment meant valuable knowledge and control of sources of supply.

He invited SWECO's proposal

Ingenuity and know-how were evident in every page of the SWECO proposal. It included field surveys and soil tests. Economic analyses and market studies. A provisional flow sheet showed the entire process graphically. Specifications, schedules, and plans were spelled out in detail. The proposal was wrapped up with a complete feasibility report.

He turned the job over to SWECO

From engineering and design, through purchasing and expediting, field construction – even through training personnel and putting the plant into operation–the SWECO engineering team took full responsibilty. It was a typical SWECO job: on-stream on schedule. Now, the oil man is a typical SWECO client. Whatever his engineering and construction needs – complete plants or additional units for an existing installation – he builds with SWECO.

For the story on what SWECO *Engineering and Construction teams can do for you in building refineries or petro-chemical plants . . . write for Bulletin E-7-29.*

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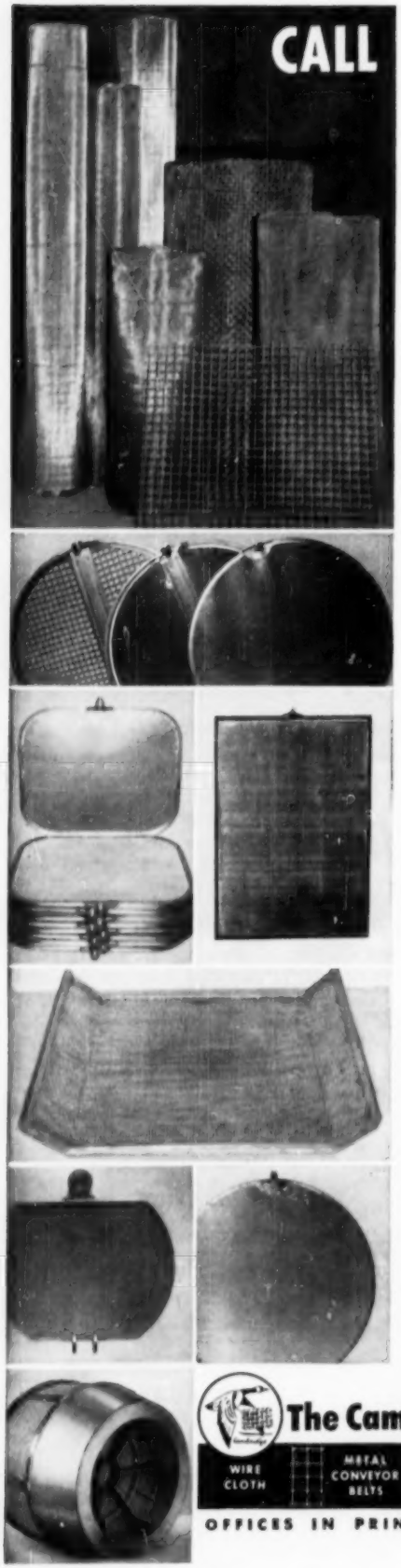

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OFFICES IN PRINCIPAL INDUSTRIAL CITIES

U.E.C. FUND DRIVE

(*Continued from page 74*)

Member Gifts Campaign

Charles F. Kettering has accepted the post of honorary chairman of the Member Gifts Campaign. He will work with the following chairmen for the Founder Societies: Enoch R. Needles, A.S.C.E.; Augustus B. Kinzel, A.I.M.E.; William F. Ryan, A.S.M.E.; Lester M. Goldsmith, A.I.E.E.; and Walter G. Whitman and S. D. Kirkpatrick, A.I.Ch.E. The Member Gifts Campaign will be coordinated and managed simultaneously among the Societies. It will be conducted on both the national and local levels with the leadership of the Societies responsible for organization and solicitation.

The first phase for each Society will be the solicitation of selected prospects for initial gifts. This phase will be carried out by a national committee of prominent and active members of the Societies. The second phase will be a personal appeal to selected prospects residing in given cities and areas throughout the country. These campaign activities will be followed by a program to obtain voluntary contributions from the members not personally solicited. The campaign is scheduled to end by December, 1958.

A.I.Ch.E. members should remember that gifts to the campaign are deductible for income-tax purposes. Campaign leaders believe that pledges can be made whereby payments can be spread over a three-year interval. Payment need not be made at the time of pledge.

The first text books are still to be written about this machine—a nuclear magnetic resonance spectrometer. Here, scientists at Michigan State U. are getting the inside story of the atom with the super sensitive machine capable of a precision of one part in 100 million. Full potentialities of the machine are still unknown. So far it has been used mainly for chemical analysis and determining molecular structures. Used for study of substances in the liquid state, the instrument can detect small impurities and has been utilized in the oil industry in analyzing hydrocarbon mixtures. It has also been used to study the motion of molecules in plastics.

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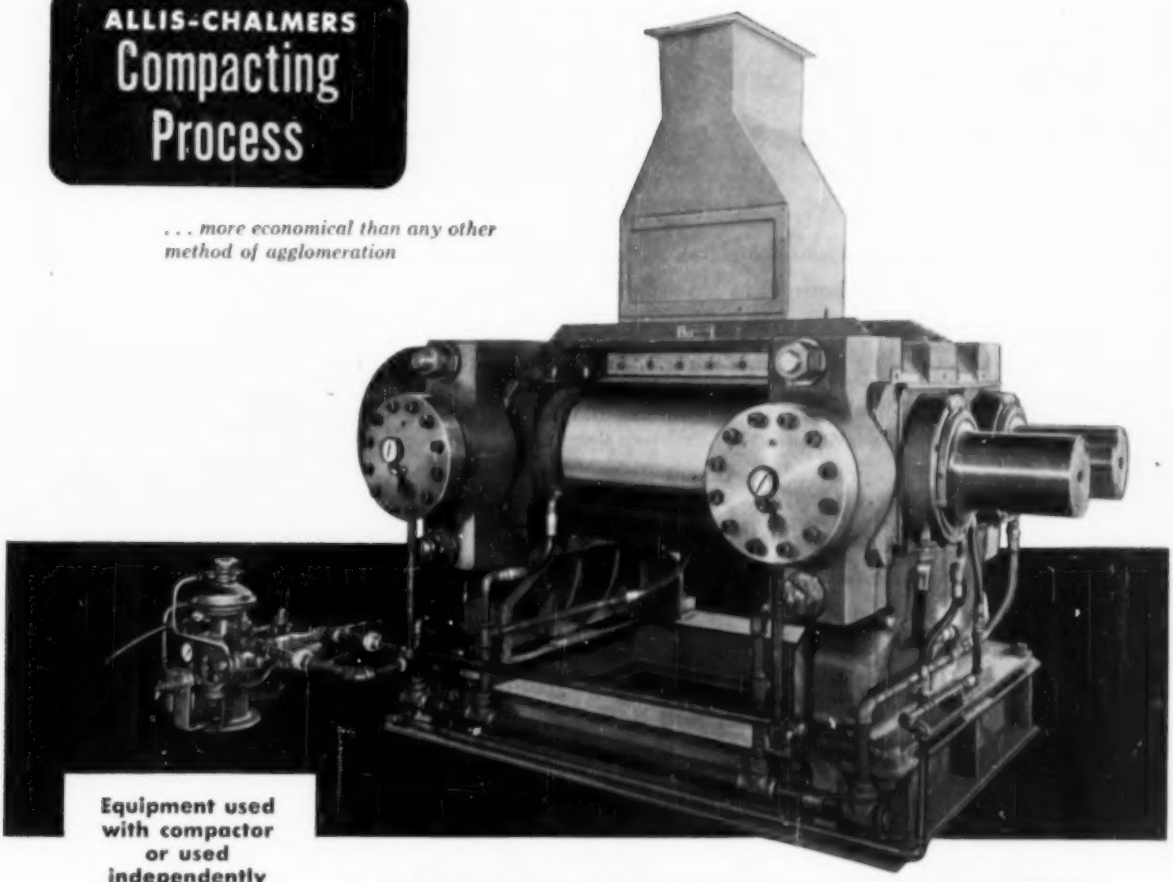
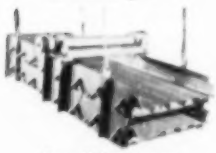
. . . more economical than any other method of agglomeration



Equipment used with compactor or used independently

Granulating Mill

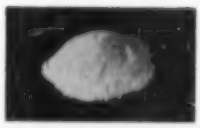


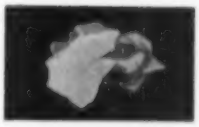
Aero-Vibe Screen

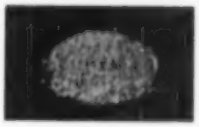
Gyratory Screen

Upgrade for Profits ...Mechanically

Precise control of *particle size, density* and *solubility factors* is now assured with the Allis-Chalmers compacting process. The heart of this efficient, completely mechanical system is this new Allis-Chalmers compacting mill.







Converts Loss into Profit

By-product material, too fine for use, from the original process, is first densified into slabs or flakes in the compacting mill. Agglomerated product is then granulated in the roller-type mill and separated in the vibrating or gyratory screen. This conversion of by-product material into a usable product changes loss into added profits.

Get Bulletin 0788836 for the complete story. Ask your A-C representative for a copy, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

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A-5582

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- to protect your processing of moisture-sensitive material
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- to DRY large quantities of fresh air from outdoors

The Niagara's Controlled Humidity Method using HYGROL moisture-absorbent liquid is

Best and most effective because . . . it removes moisture as a separate function from cooling or heating and so gives a precise result constantly and always.

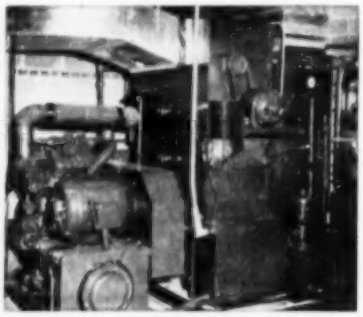
Most reliable because . . . the absorbent is continuously reconcentrated automatically. No moisture-sensitive instruments are required to control your conditions.

Most flexible because . . . you can obtain any condition at will and hold it as long as you wish in either continuous production, testing or storage.

Easiest to take care of because . . . the apparatus is simple, parts are accessible, controls are trustworthy.

The cleanest because . . . no solids, salts or solutions of solids are used and there are no corrosive or reactive substances.

This method removes moisture from air by contact with a liquid in a small spray chamber. The liquid spray contact temperature and the absorbent concentration, factors that are easily and positively controlled, determine exactly the amount of moisture remaining in the leaving air. Heating or cooling is done as a separate function.



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INDUSTRIAL NEWS

A 4,000 b/sd Platforming unit is under construction by Procon (Great Britain) for Deutsche Erdol-Aktiengesellschaft (DEA) at Heide, Germany. Shown are Platformer heaters with Unifining unit heaters (center) tied to same stacks. Unifining unit column is at right. Platforming and Unifining processes are licensed by Universal Oil Products Co.

First chlor-alkali plant west of the Canadian Rockies is in production as Hooker Electrochemical's Canadian subsidiary, Hooker Chemicals Ltd., starts up its new $12,000,000 facilities at North Vancouver, B.C. The plant is rated to produce daily 110 tons of 50 and 73 per cent liquid caustic soda, 100 tons of chlorine, and 1,000,000 cubic feet of hydrogen in 116 of Hooker's latest-design Type S-3B electrolytic cells. Cells are placed in four rows, 29 to a row.

Commercial production of two important organics, benzoguanamine and benzonitrile, is announced by Tennessee Products and Chemical Corp. Benzonitrile, basic chemical used in the production of benzoguanamine, is said to be widely adaptable for a variety of process industries including organic synthesis, plastics, rubber, pharmaceuticals, and synthetic coatings. Its derivative, benzoguanamine, is a component of resins used in the manufacture of industrial finishes, plastics, paper products, adhesives, textile finishes, and molding compounds. □

Silicon carbide capacity will be increased by 25 to 40 per cent at Norton Co.'s Cap-de-la-Madeleine, Quebec, processing plant. The new facilities are slated for completion by late 1957. □

Polyvinyl acetate emulsions will be produced at an accelerated pace by Celanese Corp., whose new manufacturing unit at Belvidere, N. J., is scheduled for early completion. □

CONTRACT ENGINEERING with a difference

from initial negotiations . . . to "on stream" you deal with Badger principals

You first make contact with Badger through a Key Man as he works with you and your engineering staff in pinpointing your processing and economic problems.

The Key Man, acting in your behalf, takes your problem to Badger engineering specialists for preliminary study and evaluation.

With recommendations approved and construction underway, the Badger Key Man is still on the spot coordinating activities. He remains in charge until your project is complete.

AN engineering project handled by Badger is a group effort involving many highly developed skills. And from first contact until the project is complete these experienced specialists are headed by a Badger Key Man. More than just a sales engineer, he is always a Badger principal — always the Key Man in the execution of the project.

This sensible operating policy, which channels project liaison, coordination and administration through a company principal, is important to you and your project. You will find that most policy level decisions can be made on the spot as situations require. Further, the Key Man's depth of experience means you deal with an executive-engineer who talks your language — knows your problems and how to find their solutions.

Many clients say Key Man Policy is the Badger difference that makes the difference. Wouldn't it be wise to inquire how it could serve to make your projects more successful?

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REGISTERED U. S. PATENT OFFICE

A JOURNAL OF USEFUL INFORMATION FOR THE SOLUTION OF CORROSION PROBLEMS

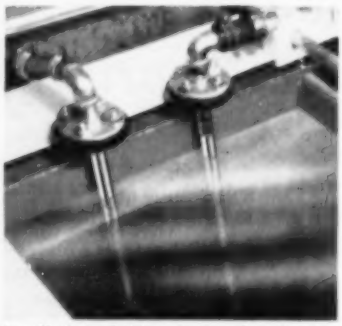
TANTALUM INERT TO ACID PLATING BATHS

The inertness of tantalum to a broad spectrum of acids and oxidizing agents has resulted in increasing usage of this metal for heating and cooling equipment in acid electroplating systems.

Plating baths are heated, usually with steam, at start-up and subsequently must be cooled in most cases during continuous operation. The heat generated by the electric power not consumed in the actual deposition of metal usually is greater than the heat lost by radiation, evaporation, etc., and that used to heat the parts being plated. Coils placed in the plating tank and external heat exchangers thru which the process solution is pumped are the chief types of heating and cooling equipment used. Corrosion is a major factor in the choice of materials for such units.

U-coils and tube and shell heat exchangers made of tantalum are widely applied in the strongly oxidizing chromium plating baths, composed of 33 to 53 ounces per gallon of chromic acid, CrO_3, in dilute H_2SO_4 at a CrO_3/H_2SO_4 ratio of 100/1. They are used with both steam and water to regulate the temperature at the desired value in the range 110°-150°F.

The temperature of the acidic nickel plating baths, containing nickel sulfate and/or nickel chloride at pH's of 0.9-4.8, is controlled similarly with tantalum heating and cooling units. Acid zinc bath temperature regulation



Installation of "U" type tantalum heaters with insulating hoses of non-conducting materials in piping.

Courtesy Metal & Thermit Corporation

likewise can be handled with tantalum equipment. In zinc baths using insoluble anodes the presence of free oxygen discharged at the anode has no effect on tantalum.

Most electropolishing is done in solutions containing a variety of acids, including perchloric, acetic, phosphoric, chromic and mixtures of these and others. With the exception of those containing HF or free SO_3, tantalum is inert to all such solutions over the temperature range used, 110° to 250°F.

In addition to its inertness to acidic solutions, tantalum has several other advantages. Thin wall tubing can be used in the heating and cooling units since no extra thickness need be provided for corrosion loss, no heat-insulating corrosion scale forms on tantalum, no contamination of the plating bath by tantalum is encountered, and space requirements are minimum.

Typical Acidic Plating Baths

TYPE	REAGENTS*	pH	TEMP.
Chromium	CrO_3, H_2SO_4	< 1	110°-150°F
Nickel	$NiCl_2$, $NiSO_4$, HBO_3	1-4	90°-160°F
Zinc	H_2SO_4, $ZnSO_4$	1-4	80°F
Copper	H_2SO_4, $CuSO_4$	< 1	70°-120°F

*Tantalum inert to these reagents

Free Tantalum Test Kit

A corrosion test kit, available without charge to research technicians, contains both tantalum sheet and wire. Request it on your letterhead.

The above condensation is typical of articles which appear in CORROSIONOMICS, a Fansteel publication. Mail us your name for inclusion on our mailing list.

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For further data on the above, write:

FANSTEEL METALLURGICAL CORPORATION

CHEMICAL EQUIPMENT DIVISION

NORTH CHICAGO, ILLINOIS, U. S. A.

G576A

INDUSTRIAL NEWS

Trithion, organic phosphate pesticide developed by Stauffer Chemical, will move into large-scale production before the next crop season, according to company officials. A "multi-million-pound" plant, projected for Henderson, Nevada, will serve both domestic and foreign markets. □

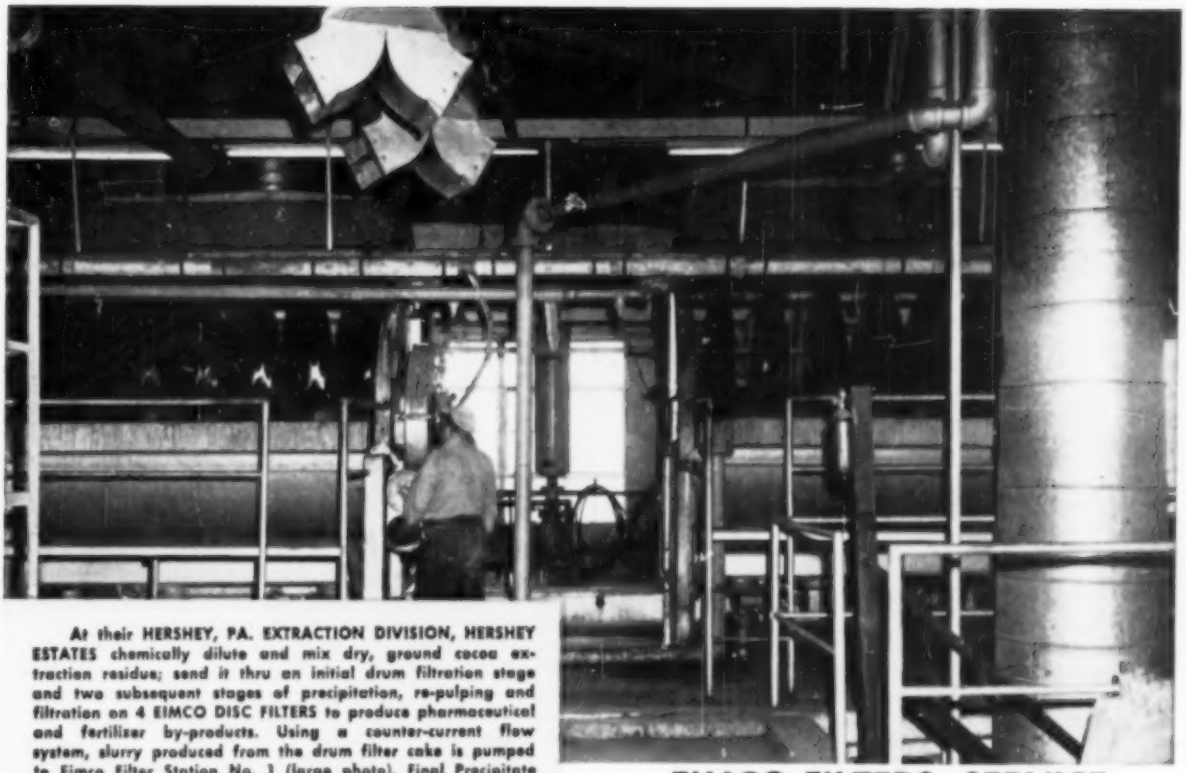
Urea in 100 ton/day lots will be coming from a new Monsanto plant at El Dorado, Ark., by early fall of 1958. The new facilities will produce urea in both prill and solution forms. Ammonia and carbon dioxide, raw materials for urea, will come from the El Dorado plant of Monsanto's Inorganic Division. □

Another ten story building in New York has been purchased by Foster D. Snell, consulting chemists and engineers. According to Snell, the new addition will virtually double the firm's capacity for chemical research and development work. □

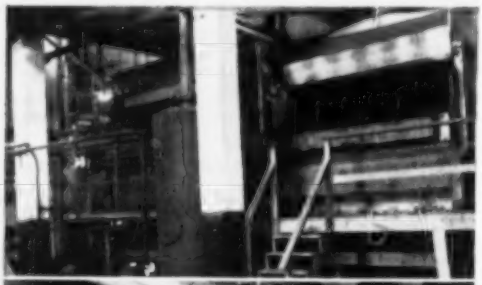
A new acetal resin, "Delrin," will be manufactured by DuPont at facilities to be constructed near Parkersburg, W. Va. Scheduled for "large-scale" production by mid-1959, the new plastic material is expected to be introduced commercially for less than $1.00/lb. □

A chemical treatment plant to process lithium ore concentrates for the production of lithium chemicals will use a new process developed by Scientific Design Co. of New York, announces Montgary Explorations Ltd., owners of the Bernic Lake (Manitoba) lithium property. Following failure of American Metal Co. Ltd. to exercise its option to participate in the venture, Montgary is reported negotiating with a group of Swiss financiers as well as Canadian mining groups interested in the large lithium ore body. □

Army's new mobile liquid oxygen plant, shown at test site, can operate at any advanced base in the world to produce LOX for fueling guided missiles. Designed and built by Air Products, Inc., of Allentown, Pa., the units can produce 20 tons of LOX per day.



At their HERSHEY, PA. EXTRACTION DIVISION, HERSHEY ESTATES chemically dilute and mix dry, ground cocoa extraction residue; send it thru an initial drum filtration stage and two subsequent stages of precipitation, re-pulping and filtration on 4 EIMCO DISC FILTERS to produce pharmaceutical and fertilizer by-products. Using a counter-current flow system, slurry produced from the drum filter cake is pumped to Eimco Filter Station No. 1 (large photo). Final Precipitate is gravity fed to Eimco Filter Station No. 2 (directly below), and the end-product is transported to storage on a continuous belt conveyor. Bottom photo shows closeup of Eimco Disc cake formation.



EIMCO FILTERS - SERVICE WIN HERSHEY'S CONFIDENCE

HERSHEY, PA. - Client confidence in Eimco filter equipment and service over a period of 15 years, is expressed by **Mr. H. B. Brewer,** operating manager of the **Extraction Division, Hershey Estates.**

In 1941 . . it became feasible to add a two stage precipitation, re-pulping and disc filtration process to the flowsheet producing by-products from dry, ground cocoa extraction residue.

Mr. Brewer describes operation of two disc filter stations subsequently designed and installed by Eimco, "highly satisfactory. Over a 15 year period of around the clock operation, they have given us a dependable, efficient operation that has increased production and improved product quality."

This performance is a tribute to the durability and high mechanical operating efficiency of **Eimco** equipment and **Hershey's** intelligent maintenance program on a "planned" rather than "emergency" basis. From time to time, **Eimco** engineers and **Hershey** technologists have worked hand in hand to develop improvements to bring plant capacity to its present 90 tons of solids-per-day production.

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B-288

washington feedback *Joseph L. Gillman, Jr.*

Public opinion and the panic button

Post-Sputnik reactions in Washington are resulting in a literal buzz of discussions—from private comments to public speeches—calling for greater and more effective activity on the part of the nation's scientists and engineers.

When Washington talks this excitedly about an issue, it usually means that action on the part of administrative agencies and legislative bodies is soon to be shaped and debated. In the meantime, public attention to the subject begins to be reflected in the actions and utterances of the members of Congress, and if the issue is hot enough, consideration soon starts on bills to be entered by their proponents on the slate of the next Congress.

Because the American public is already aroused on this issue, and as Congress is soon to convene, many here believe that we are already in a period of quiet before the storm. This, according to such views, is the result of an anxious public waiting sceptically for technologic leadership suddenly to arise and produce immediately tangible and visible results which would reclaim a lost world leadership in science.

Under these circumstances, whether or not such a conclusion is correct, it is evident that a moment in history which represents great opportunities for the engineering and science professions is at hand.

Soon, the technologic professions may be offered practically anything they want, if they will only show the way to get the job that's wanted, done. The prestige of the technologist may suddenly be catapulted—like a Sputnik—to the highest level yet, through actions by the Administration, repeated statements by our highest leaders, and through appeals to the professionals themselves.

Period of Opportunity

A period of unquestionably great opportunity lies ahead in the Nation's Capital for the engineer. But to take advantage of this opportunity means that he must be forcefully represented on issues to be affected by him; and likewise represented on issues which in turn will greatly affect his future status, perhaps even his future freedom from impeding regulation.

Earlier, it was mentioned that many believe the public temperament to be such that it sceptically awaits the arising of technologic leadership which will produce immediate results. The same persons who hold this view almost invariably believe that the public will not wait long before it will begin appealing in panic to the loudest peddler of national nostrums. This panicky fear (that something horrible will happen to us because of a feeling that the Soviets lead us technologically) may in all probability cause their duly elected representatives to take action.

The immediate danger lies in the nature of the action of these elected representatives under such pressures. Action in this case, according to experienced Washington observers, is almost certain to be based on incomplete information, and lack of experience and knowledge in the setting up of such vast technologic programs.

The only effective counter to such ill-advised regulatory measures is for the scientific and engineering organizations to speak vigorously to the men on the "Hill" forced to take such actions, reaching them with the information or guidance that is necessary to enable them to make the proper moves—proper in that they will *in reality* assure our reclaiming any leadership that we may have lost in the eyes of the world.

The issue before our legislators is to find ways of putting our scientific and engineering population into immediate, efficient use. A goal of such consequence cannot be achieved through the mere passing of laws based on what others *think* scientists and engineers can and will do. Legislation is important—is of course necessary. It is something that needs to be handled by experts—but experts in legislation. Such experts normally expect to be advised. But so far, the advice they appear to be receiving (or that has been announced) is falling far short of being commensurate with the scope of the problem.

Many of us on the Washington scene are eagerly awaiting the appearance of actions on the part of the engineers and scientists that will quickly get the real issues out in the open.

Applications are now being accepted in four National Science Foundation fellowship programs for advanced study and research in the natural sciences. 1) A pre-doctoral program for graduate students and college seniors. 2) a postdoctoral program for those who have already received the doctoral degree. 3) a senior postdoctoral program for candidates who have held the science doctorate for a minimum of five years. 4) a science faculty fellowship program for college teachers of science who wish to improve their competence as teachers. Applications for the 1958-59 programs of the first two may be obtained from the Fellowship Office, National Academy of Sciences—National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D. C. Closing dates for applications are: seniors and graduate students, Jan. 3, 1958; postdoctoral, Dec. 23, 1957.

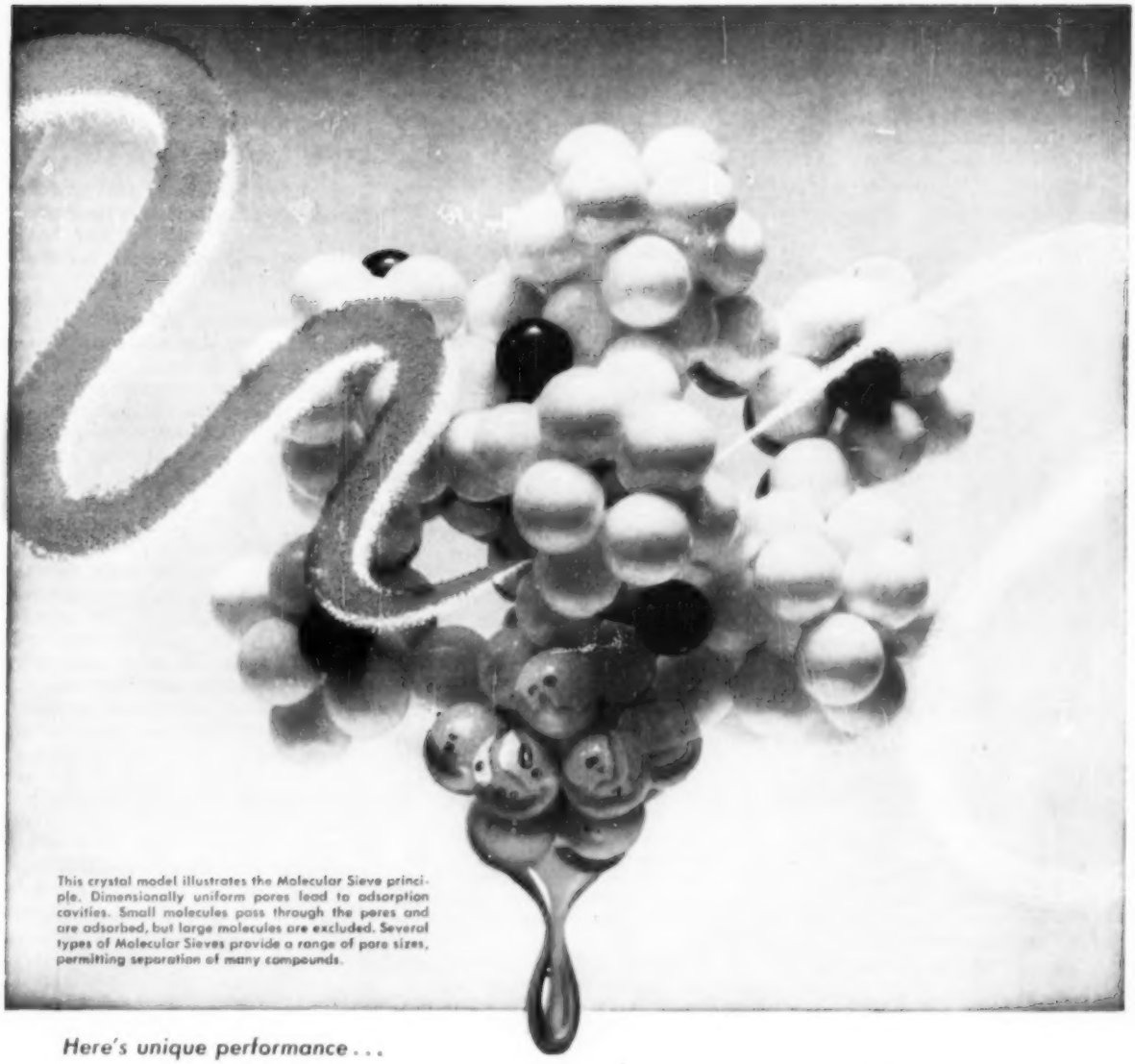
Applications for the second two programs may be had from the Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D. C. Closing date is Jan. 13, 1958. □

OPPOSITION TO EDUCATION SPEED-UP

The United States should "not rush into hastily improvised actions having to do with the education of engineers which would only aggravate a complicated and difficult condition that cannot be solved by spur-of-the-moment solutions." So says the National Society of Professional Engineers in a recent public statement on Sputnik-inspired proposals for a crash program for training engineers.

Seven points are advanced by N.S.P.E. as bases for its stand:

- Engineering enrollments are at an all-time high and are continuing to increase.
- Artificial stimulation to increase enrollments could prevent adequate attention to capable students.
- Russia's satellite success can more logically be attributed to priority factors than to a shortage of technical personnel in the U.S.
- Now, more than ever, emphasis should be placed on quality rather than on quantity.
- Substantially increased enrollments in our engineering institutions are causing serious difficulties at the present time.
- Projects such as the earth satellite, guided missiles, etc., depend on highly advanced technology. A program starting today will not produce a single highly qualified engineer or scientist for at least six years.
- Improved utilization of engineering talent can do more for our immediate needs than any other single program.



This crystal model illustrates the Molecular Sieve principle. Dimensionally uniform pores lead to adsorption cavities. Small molecules pass through the pores and are adsorbed, but large molecules are excluded. Several types of Molecular Sieves provide a range of pore sizes, permitting separation of many compounds.

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Molecular Sieves, a new class of adsorbents developed by Linde Company, offer selective separation of gas or liquid mixtures in three ways . . . difference in molecule size . . . or polarity . . . or carbon bond saturation. And, co-adsorption can be utilized to remove several impurities simultaneously.

Typical uses? Removal of catalyst poisons from olefins . . . or extraction of olefins from refinery streams and top gases . . . or simultaneous dehydration and sweetening of natural gas . . . and many, many others.

LINDE Molecular Sieves offer new performance advantages . . . for many production uses. You may be able to lower costs, simplify processes, improve a product with this unique adsorbent. Find out more by writing for data describing Molecular Sieve properties and performance characteristics, Dept. CP12, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y.

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Linde TRADE MARK MOLECULAR SIEVES

UNION CARBIDE

Mr. Gene Lane, Utility Operator, at the Central Soya Co., Inc., Chattanooga, Tenn. plant, operates 36 Merchen Scale Feeders that blend feed ingredients to 1% accuracy

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"give us accurate, continuous blending over a wide feed range"

Central Soya Co., Inc., blends millions of bags of animal and poultry feed a year at their new Chattanooga plant. Up to 50 different formula feeds are produced to exacting standards. Central Soya chose W&T Merchen Feeders because they give 1% minute-to-minute accuracy over a wide feed range. As seen in the picture, the feeders are compact — with no bulky enclosures.

Merchen Scale Feeders, with feed rates from 3 to 3000 pounds per minute, require no adjustment for changes in material density. They are suited for most industrial continuous blending or automatic batching processes. For more information about Merchen Scale Feeders, write for Bulletin M-34.

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ENGINEERING EDUCATION REPORT BY NSF SHEDS TIMELY LIGHT

Of 1,900 resident post-graduate students of chemical engineering, only about 800 receive any financial aid; average stipend for those aided is $1,400.

A sharp focus on post-graduate engineering in the U.S. is provided by the publication of the results of a comprehensive survey conducted by the National Science Foundation.* Says the report: "Almost 1,900 resident students of chemical engineering were reported to the Foundation, the third largest enrollment in any engineering field. Relatively large proportions of students were studying full-time and in advanced years of study (49 per cent in each case), and the proportion of doctorates among degrees awarded during 1953-54 (25 per cent) was larger than in any other engineering field with as large an enrollment.

"The average enrollment per department (24 students) and the proportion of students in departments enrolling 50 or more (42 per cent) were low for engineering. As usual, the Northeast reported the largest enrollment of any region (43 per cent): nevertheless, there were relatively fewer students of chemical engineering than of engineering as a whole in the Northeast, and more in North Central and Southern States. In these three regions (but not in the West or Pacific) the distribution of students was closer to the pattern of chemistry than of engineering."

How much Federal Government aid is presently being received by post-graduate students of chemical engineering? Figures for 1953-1954 (the latest available) show that, out of slightly more than $1,000,000 spent annually on the support of about 800 students, $422,000 (35 per cent) came from educational institutions, $341,000 (29 per cent) from the Federal Government, and $428,000 from other sources.

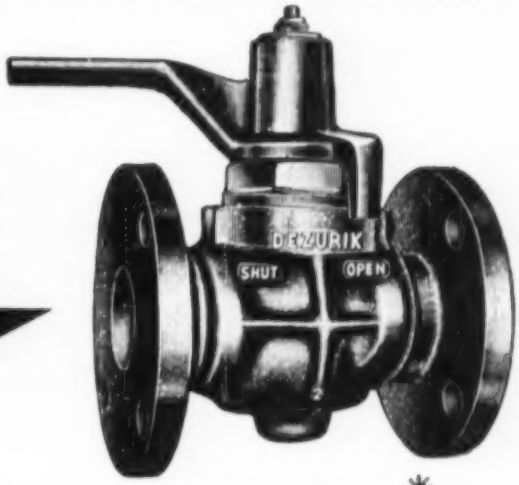
The proportion of resident students supported (43 per cent) was the highest among large engineering fields, although considerably below that in chemistry, where 67 per cent was supported. The per cent of chemical engineering students with teaching and research assistantships (12 and 17 per

(Continued on page 86)

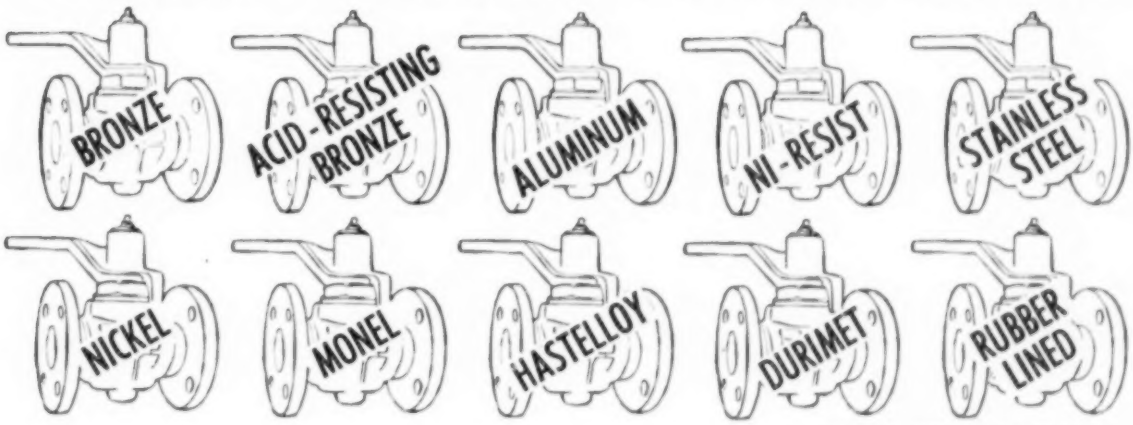
* "Graduate Student Enrollment and Support in American Universities and Colleges" (NSF 57-17), United States Government Printing Office, 1957, Price $1.50.

WHAT'S YOUR CORROSION PROBLEM?

HERE'S THE ANSWER!



DeZurik Valves are available* in



* AND OTHER METALS

PLUGS ARE AVAILABLE WITH HYCAR, NEOPRENE, HYPALON, HARD RUBBER OR TEFLON FACING.

DeZurik Valves' complete range of materials is matched by a complete line of models: manual, pneumatic, hydraulic or electric operation. DeZurik's **exclusive** eccentric action guarantees dead-tight shut-off and easy operation **without lubrication!** For more details on DeZurik Valves, write to

Representatives in all principal cities.

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SARTELL, MINNESOTA.

"CANADA DRY BEVERAGES CHOOSE E-D FILTER PAPERS TO GET SPARKLE AND PURITY!"

J. L. Murphy, Jr., Vice-President in charge of production for Canada Dry Ginger Ale, Inc.

"For 30 years, we have used Eaton-Dikeman filter papers to obtain the sparkle and purity that are essential in maintaining the quality for which Canada Dry Beverages are known and liked", says Mr. J. L. Murphy.

"Our beverages are sold to millions of consumers each year. They are a discriminating and exacting jury. Clarity, flavor, sparkle must be up to top standards at all times to hold their loyalty. Thus, in the final stages of polish filtration, we must have a *dependable* and *uniform* filter medium. We have found that Eaton-Dikeman filter paper, year in and year out, fulfills these requirements.

"In addition to fine porosity, E-D filter paper has very high rapidity, which is a requisite for maintaining the high production rate of Canada Dry Beverages.

"Filtration is a very important part of our operation. Every bottle that leaves our plant must be sparkling, clear and pure. E-D filter paper helps us uphold these standards."

To get maximum clarity for your filtration, let us recommend the grade you ought to try. E-D samples for test runs gladly furnished without obligation.

E D *The Eaton-Dikeman Company*

FILTERTOWN
MOUNT HOLLY SPRINGS, PENNSYLVANIA

INSTITUTIONAL NEWS

REPORT ON ENGINEERING EDUCATION

(Continued from page 84)

cent, respectively) was high; another 14 per cent—more than twice the average proportion—held fellowships, mostly from industrial sources (as was also the case in the field of chemistry).

The median stipend received by chemical engineering post-graduate students, $1,400, was on the low side for engineering; electrical engineering students received $1,770 on the average and mechanical engineering students $1,515, while the average for all engineering students was $1,560. However, the median stipend for engineering as a whole was higher than for any other field of graduate study.

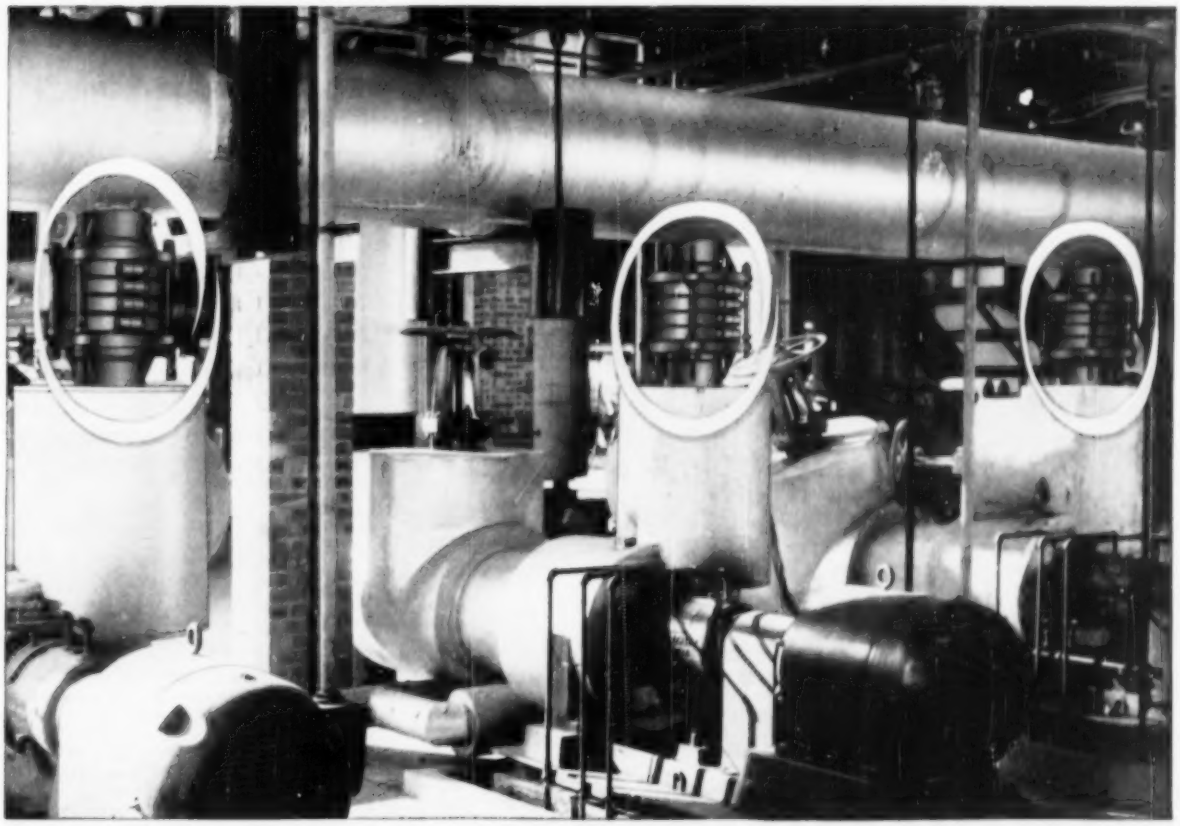
This timely publication of the facts of the actual situation will undoubtedly be of immense help in formulating a reasonable, non-hysterical program to meet the evident Russian challenge in scientific education.

A program to bring high school chemistry teachers up to date on scientific developments and classroom instruction techniques is underway at Brooklyn College in New York with the cooperation of Chas. Pfizer & Co. Twenty-five New York city teachers who have been out of college for ten or more years will attend 15 two-hour class periods, three of which will be lab work. Designed to stimulate student interest in science by bringing the latest advances in chemistry into the high school classroom, the course is being offered free-of-charge with payment of registration and tuition fees provided by Pfizer. □

A grant of $23,900 has been made to Rensselaer Polytechnic Institute by the National Science Foundation to support a three year program of research concerned with a study of the thermodynamic properties of liquid and vapor solutions. Directing the research is H. C. Van Ness, associate professor of chemical engineering. □

The Federal Trade Commission has filed a proceeding against Procter & Gamble attacking the recent acquisition of Clorox Chemical Co. □

High-impact styrene production capacity will be more than doubled at Monsanto's Plastics Division plant at Springfield, Mass. The expansion is scheduled for completion in May, 1958. □



ADSCO CORRUFLEX EXPANSION JOINTS SOLVED A PIPING PROBLEM FOR NATIONAL ANILINE

The new $20,000,000 diisocyanates plant of the National Aniline Division, Allied Chemical & Dye Corp., at Moundsville, W.Va., is known for many engineering wonders, especially its miles of intricate piping. The photo above shows three ADSCO Corruflex anti-compression packless expansion joints used to secure satisfactory piping connections between the main piping and three pumps.

If rigid piping had been used to connect the three pumps to the 18-inch main feeder, the piping soon would have been twisted and overstressed by the growth of the main feeder when hot process liquid was pumped through it. National Aniline engineers, in consultation with ADSCO engineers, decided to use the anti-compression joints shown in the photo. These are deflected laterally with minimum strain on the connecting piping and pumps as the main feeder expands or contracts. Also, the joints absorb vibration of the pumps and motors.

For efficient, right-working pipe line arrangements, use ADSCO Corruflex expansion joints. Packless, they require no maintenance. Sizes, 3" to 54"; for temperatures to 1600 F and pressures to 300 psi.

REMEMBER! Use ADSCO Expansion Joints instead of Pipe Bends because of these advantages:

1. Less Heat Loss **2. Less Pressure Drop** **3. Less Space** **4. Less Cost**

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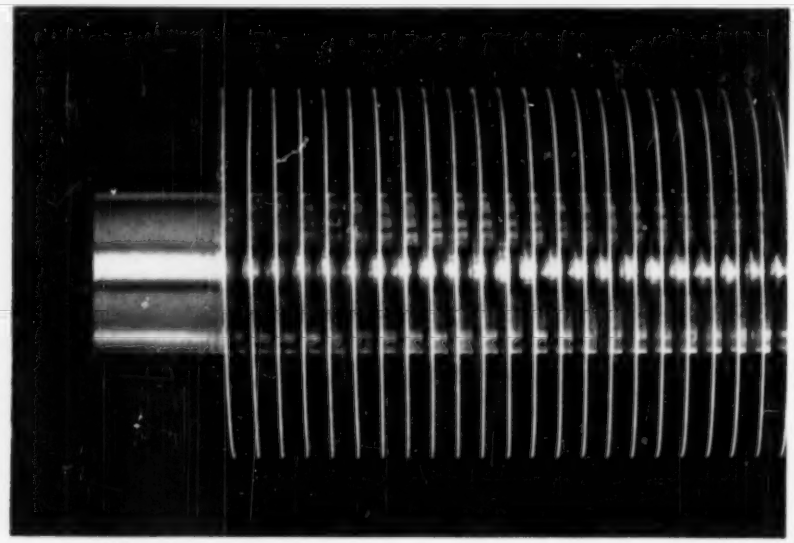

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Greater Heat Transfer
per sq. ft. of face area

Lower Airway Resistance
—less power per c.f.m.

Aerofin smooth fins can be spaced as closely as 14 per inch with low air friction. Consequently, the heat-exchange capacity per square foot of face area is extremely high, and the use of high air velocities entirely practical. Tapered fin construction provides ample tube-contact surface so that the entire fin becomes effective transfer surface. Standardized encased units arranged for simple, quick, economical installation.

AEROFIN CORPORATION
101 Greenway Ave., Syracuse 3, N. Y.

Write for Bulletin S-55

Aerofin is sold only by manufacturers of fan system apparatus. List on request.

SALUTE TO SIXTY-YEAR HISTORY

The Chemists' Club of New York celebrated its sixtieth anniversary November 20 with publication of a handsome, red and gold volume titled "Six Decades of the Chemists' Club." Written by David H. Killefer, with drawings by George Hollrock, and printed by the Peter Pauper Press, this memorial volume will be available free to Club members. Price to non-members is five dollars.

Among New York Chemists' Club members present at a recent meeting to discuss expansion of the club's library were (l. to r.): Robert L. Bateman, Union Carbide and Carbon; Lincoln T. Work, independent consultant; and Kenneth Klipstein, American Cyanamid. Plans were discussed for the implementation of a program to continue the expansion of the library facilities (at present over 50,000 volumes) and to assure the most efficient use of this material.

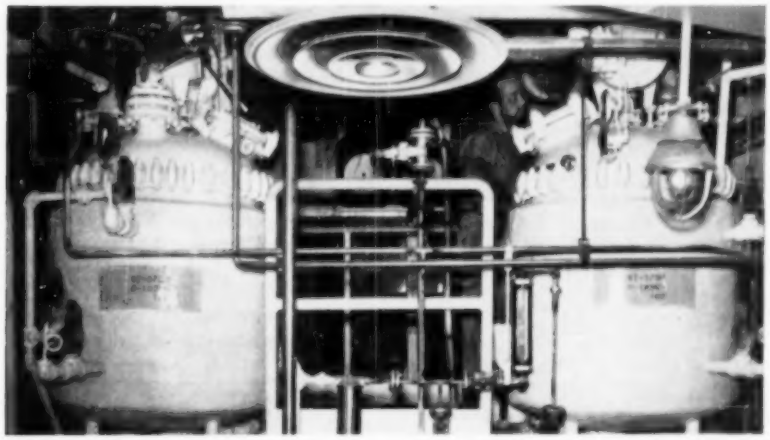
Brooklyn "Poly" has a new home. This September, more than three-fourths of some 5,900 graduate and undergraduate students at Polytechnic Institute of Brooklyn were relocated in new and modern quarters. Conversion of a block-square industrial plant purchased in 1953 for $2,000,000 has provided two eight-story industrial type buildings and a five-story administration building. Five blocks north of the Livingston St. buildings, the new facilities include 65 classrooms, 83 laboratories, a 400-seat auditorium, a library, a cafeteria, and assorted club rooms and lounges. □

Project 200 is a unique program for 200 civilian specialists in scientific fields to be granted commissions in the Regular Army. Chemical engineering is one of the critical fields looking for officers, rank will depend on age, requirements are a Ph.D. degree, or a master's with three years experience in the field, or a bachelor's with five years experience. The army has a full booklet giving details and advantages of the program. It can be had from Maj. Gen. H. M. Jones, The Adjutant General, Dept. of the Army, Washington 25, D. C. □

Corrosioneering News

Quick facts about the services and equipment available to help you reduce corrosion and processing costs.

Published by The Pfaudler Co., a division of Pfaudler Permutit Inc., Rochester, N.Y., U.S.A.



Isolating finished steroids is done in these two Pfaudler glassed steel reactors at Merck & Co.'s Cherokee plant. Absolute cleanliness and corrosion resistance are musts here as in all other parts of complex steroid production which involve several highly corrosive acids. See text.

New MERCK Plant a Classic Study in Corrosive Processing

You're putting a new product into production. Serious corrosion problems are involved. You must justify the need for special equipment in terms of profit return on capital investment. Such were the problems met at the new Merck & Co. plant in Danville, Pa.

The plant makes steroids to pharmaceutical grade specifications. Bromine, hydrobromic acid, chlorine and hydrochloric acid, and a series of organic acids are just a few of the corrosive substances that enter into the complex reactions that produce the steroids.

What sort of equipment do you use to produce steroids that satisfy both the quality controllers and the company comptrollers who expect a fair return on their equipment investment?

Experience is the answer

Because of their long, long experience with corrosives, the men at Merck found that the problem spelled out its own answer: Pfaudler glassed steel equipment.

Pfaudler glassed steel because this construction material withstands more corrosives than any other — including the halogens and acid halides mentioned above.

Pfaudler glassed steel because it cannot act as a catalyst itself nor will it release trace metals which might trigger treacherous side reactions.

Pfaudler glassed steel because of ease in cleaning and operational

Bromine, Chlorine and their acids are among the biting corrosives handled by these Pfaudler intermediate series kettles at Merck plant. Merck engineers specified Pfaudler without hesitation, basing their confidence on long experience with Pfaudler glassed steel reactors and storage tanks.

longevity—twenty to thirty years of corrosion-free service in many instances.

Pfaudler glassed steel, finally, because of successful experience—our own 73 years of experience and the experience of companies such as Merck to whom "corrosioneering" is a continuous and profitable study.

Four ways to avoid thermal shock damage to glassed steel

We'd be among the last to ask you to *baby* Pfaudler glassed steel, but we do know for fact that *a little tender care* will help your vessels last longer. Tender care such as this:

One. Keep your operating temperatures below 450°F. unless you consult with our engineering department. This limit can be exceeded but it calls for careful study.

Two. Watch your temperature differentials, especially when dumping a cold charge into a hot vessel.

On *standard* vessels up to 2000 gallons, we usually recommend these temperatures:

Reactor temp.	Charge temp. should be at least	Safe temperature differential
250°F.	50°F.	200°F.
300	125	175
350	200	150
400	270	130
450	335	115

When emptying a hot medium into the jacket of a cold reactor, the difference between jacket and reactor temperature should not exceed the "safe" temperature shown above.

Dumping a hot charge into a cold vessel is not as critical, but we recommend a maximum temperature differential of 200°F. throughout the temperature range at which you normally use the equipment.

Three. Be careful when welding or torch cutting. Do not weld to the tank proper under any circumstances. Use electric welding to the jacket, never acetylene. When welding to the jacket sealer, keep at least 2" away from the tank proper.

Four. Take note of the heat developing from exothermic reactions inside the vessel. Damage to the glass is unlikely unless the reaction gets completely out of hand. For safest operation, however, we recommend that the 200°F. differential be maintained.

THE PFAUDLER CO.,
a division of PFAUDLER PERMUTIT INC.,
Dept. CEP-127, Rochester 3, N.Y.

Please send me: ☐ Bulletin 955, Installation of glassed steel reactors; ☐ Bulletin 947, Buyer's Guide.

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AEC proposes to process spent fuels

Commission plans interim solution to problem of handling irradiated fuels discharged from private power and research nuclear reactors.

For an interim period, the AEC is planning to process irradiated fuel elements from private research and power reactors in existing Commission radio-chemical facilities. This decision resulted from a recent AEC survey which revealed that private industry is not yet ready to undertake the job under the current Commission program for industrial participation in radio-chemical processing.

Industry does not believe the prospective income from currently available business is sufficient to warrant the risks involved in a substantial investment in new facilities, in view of the uncertain growth of reactor fuel business, uncertain knowledge of the fuel elements involved, and problems associated with waste storage and disposal, the survey showed.

An integral portion of the fuel cycle of nuclear reactors is the radio-chemical processing of irradiated fuels. Such processing is presently performed only by government-owned plants at various AEC sites. Processing of radioactive fuels from private facilities, according to this proposal, would occur at the government-owned plants, which would be modified as necessary to handle such a volume of irradiated fuels.

Before these facilities can be used, however, additional funds must be obtained to make the necessary modifications.

It should be noted that the Commission has not altered its original objective: having private industry build and operate such plants for this purpose. Therefore, the AEC processing plants are planned only as an interim effort, subject to cancellation on 12-months notice when fuel element processing services become available commercially at reasonable prices.

The following discussion of the AEC's role in the processing of spent fuels from licensed reactors is taken from the remarks of R. W. Cook, Deputy General Manager of the AEC, before the Fourth Annual Conference of the Atomic Industrial Forum on October 28, 1957.

The AEC announced, in January 1956, a program to encourage private industry to build and operate chemical processing plants. We chose as the initial step a program of technical meetings which was directed toward providing industry—in a condensed form—the technology which was available to the AEC in the field of chemical processing. The papers presented at these technical meetings are available through our technical information service. The information presented at these meetings provided basic data necessary to those organizations who wished to make a more extensive study of chemical processing. More recently, the Commission presented a number of papers at a chemical processing symposium held in Belgium in May of 1957. These papers are also available through our technical information service.

We also recognized that some form of direct AEC assistance might be necessary to enable industry to build and operate private plants, for reasons such as the following:

• the fuel processing load available initially may not be large enough;

• the fuel processing technology has not been advanced to the desired stage of development;

• the design, composition, and quantities of the fuels to be processed have not been finally determined.

The Commission decided, in January, 1956, to offer certain AEC irradiated fuels as a guaranteed base load for a private plant as a concrete item of assistance. This base load, which would be supplied under a contract with AEC for processing services, was intended to assure the processor of a reasonable load during the first years of plant operation.

During this period it became apparent that, before an industrial organization would be in a position to process spent fuels and to quote prices which would not discourage the growth of nuclear power, it would be necessary for the AEC to establish firm charges for this service. These charges were needed to allow firm planning by industry for the design, construction, operation and financing of nuclear power reactors. Accordingly, the AEC set out to develop reasonable and consistent charges for such processing services.

Contracts Offered

On February 18 and March 12 of this year, the Commission announced that it would cater into contracts with private reactor operators to provide for processing of their irradiated fuels on the basis of firm charges, until such time as commercial facilities having the required processing capability become available. The AEC further stated that the contracts with the reactor operators would be cancelled upon not less than twelve months notice when it is determined that processing services will become available in commercial facilities at reasonable prices. A conceptual plant, capable of handling a variety of spent fuels, was selected as the basis for establishing charges for AEC processing services. Because the government does not incur certain costs normally experienced by industry, the Commission also decided at this time that prices in the order of 15 per cent higher than the charges computed by the AEC would be considered reasonable prices to be charged by industry. The need for establishing charges and the bases for such charges were given the most searching consideration within the AEC. After a review of all the foreseeable ramifications, the Commission felt that the need for providing industry with processing charges was urgent, and concluded that the AEC basis for the charges, as contained in the Federal Register Notice of March 12, 1957, should be used. It was our feeling that reasonable charges must be made available if we are to bring into being a nuclear power industry. It was also the feeling that a commercial processor could meet the Commission's criteria of reasonable prices. It was recognized that this would be difficult and would likely involve some risk and small profit during the early years of operation.

Since our initial announcement of an AEC assistance program in January 1956 we had been studying the terms and conditions under which the AEC could accept proposals for processing services on the base load for a commercial plant.

(Continued on page 92)

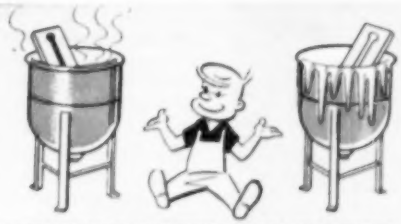
How to evaluate materials of construction for the chemical plant

Choosing materials of construction for chemical-industry equipment is a complex job. The first step toward the solution of a new problem is the analysis of all the requirements that can be anticipated. If they indicate one or more of the properties shown, thances are that Crucible *stainless* steel is the most practical choice you can make.

RESISTS CORROSION – Stainless is almost impervious to attack by oxidizing acids like nitric acid. It resists strong alkaline solutions, and many other chemical compounds.

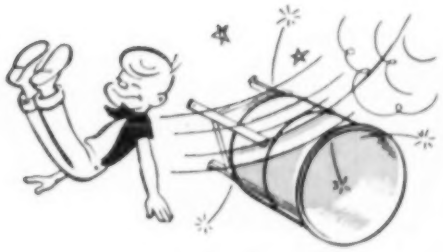
PREVENTS CONTAMINATION – With stainless there's no pickup of metallic ions or deterioration in the product. Stainless stays out of the process solution.

CLEANS EASILY–Even for the most rigorous cleaning problem–that of decontamination to remove radioactive matter–stainless is chosen decisively over other materials.



WITHSTANDS TEMPERATURE EXTREMES – At very high temperatures, stainless stays strong. At very low ones, it does not become brittle as other metals may.

PROVIDES GREAT STRUCTURAL STRENGTH –Stainless is about 50% stronger than mild steel. It permits lightweight, durable construction of chemical processing equipment.



RESISTS WEAR AND ABRASION – Erosive and abrading action makes the surface of stainless harder. It's ideal for mixers, chutes, bins and piping.

ALLOWS COMPLEX FABRICATION–Stainless can be cut, bent, drawn, welded, machined, forged, spun, riveted, cast–fabricated by all the common metal-working processes. Stainless imposes no restrictions on equipment design.

Crucible metallurgists have had considerable experience with stainless in chemical applications. They will be happy to work with you to make the best, most economical use of stainless in your plant. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

Send for a copy of the 44-page booklet "Making the Most of Stainless Steels in the Chemical Process Industries". It's packed with data you can use.

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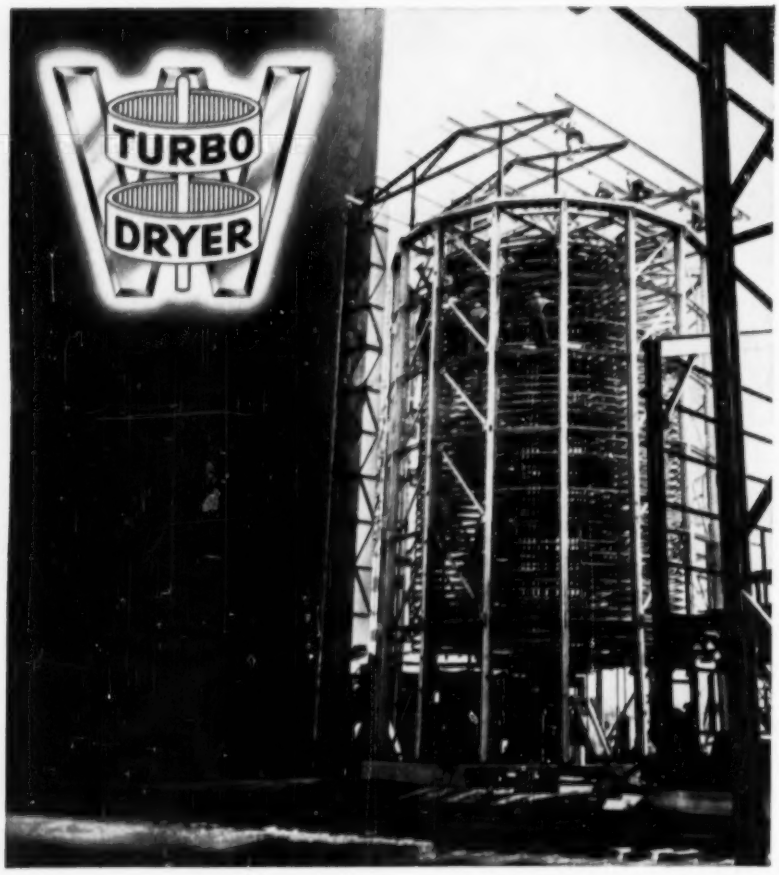
to the Process Industries



This trademark stands for 25 years of important service to the process industries. During this time a great many custom engineered TURBO-DRYER® installations have solved difficult processing problems and have increased profit margins. These installations are distinguished for their performance—close tolerance control, non-degradation of product and continuity of operation.

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As in the past Wyssmont will continue to work closely with customers, utilizing its trained engineering talent and advanced testing facilities for solving new challenging problems.

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PROCESSING SPENT FUELS

(*Continued from page 90*)

In April of this year we decided to explore with industry their interest in constructing a plant to process fuels from licensed reactors with the assurance of a base load of AEC irradiated fuels. A number of companies interested in this field were requested to submit comments on a proposed invitation containing the terms and conditions under which the AEC would accept proposals for processing the base load.

The proposed invitation for competitive proposals was generally unacceptable to industry for a number of reasons, and no alternative bases acceptable to the AEC were included in the replies received. It was the concensus of the companies that the income from a plant, using the AEC definition of reasonable cost, would be insufficient to provide an acceptable return on the capital investment required. The unknown increase in development costs when fuels are changed to more competitive ones, the complexities of the storage and disposal problem, and the probable rapid obsolescence of some of the processes selected for the plant were some of the specific deterrents noted by industry. The AEC does not wish to invite proposals from industry when there appears to be no reasonable chance that acceptable arrangements will result. Accordingly, the AEC does not intend to issue a formal invitation for proposals at this time.

Since industry appears unready at this time to undertake a major effort in the radiochemical processing of fuels from licensed reactors on the basis proposed, the AEC has been left with the problem of how to prepare for the processing of fuels returned from licensed reactors and to recover the valuable special nuclear materials while still planning to have industry assume responsibility for processing private fuels at a later date. After a study of the possible alternatives, the AEC decided to process these fuels in existing developmental and production facilities for an interim period until industry builds plants for the recovery of source and special nuclear materials from licensed spent fuels.

As the processing load, the processing technology, and the composition of nuclear fuels become better known, we expect industry will begin processing the fuels from licensed reactors before the June 30, 1967 expiration date of our contracts with reactor operators. Our present plans do not contemplate processing these fuels in existing facilities beyond the expiration date of these contracts. Since it is our intention not to stay in this business, every effort will be made to minimize such modifications as will be necessary to these facilities and to postpone actual expenditures of funds until the latest possible date consistent with the need

to keep recovery on a reasonable current basis. We do not consider the use of existing AEC plants for performing the recovery services desirable over the long-term. This plan has been selected with the confidence that the economics of chemical processing will change and that industry will build and operate processing plants in the near future.

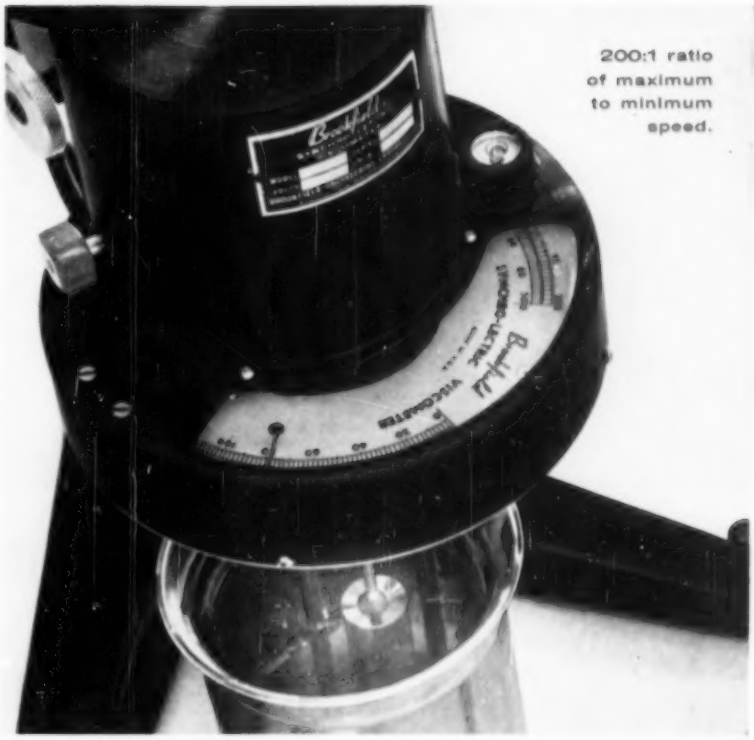
To support our objectives, as well as to provide the AEC with the data necessary to process these spent fuel elements on an interim basis, we will continue to direct our research and development effort toward both our immediate problem of modification of existing facilities and our longer range interest in developing new, low-cost processing methods. We will also continue to direct our effort toward developing solutions to the waste storage and disposal problems.

While we do not at this time plan to issue an invitation offering specific AEC assistance in the form of a base load, I hope that it is clear to all that the way is open at any time for industry to build and operate a purely commercial processing facility subject only to the Commission's licensing requirements. We are hopeful that some companies may find it attractive, perhaps as part of their development programs, to undertake at least a limited effort in this field.

In addition, we encourage you to discuss with us your views and comments on any aspect of this area of atomic energy activity. These contacts will greatly assist us in our effort to arrive at a basis for industrial participation which will be acceptable to both the AEC and industry. We will give serious consideration to any basis for a proposal which you may suggest. We will again consider the offer of a base load, similar to the one previously made, when industry indicates that such assistance may result in satisfactory arrangements for the processing of private power fuels.

In its January, 1956 announcement the AEC noted that Commission facilities may be utilized by private firms for research and development, and for training in connection with chemical processing. The full costs of such utilization would be defrayed by the user. I wish to call this to your attention since no one has taken advantage of this offer. We feel that the work experience program, or training program, offers the fastest and least expensive way to train personnel and obtain up-to-date technology in this field.

With respect to the technology of chemical processing, the developmental data being obtained at all of the AEC sites on the processing of private fuels will be made available through the technical information service.



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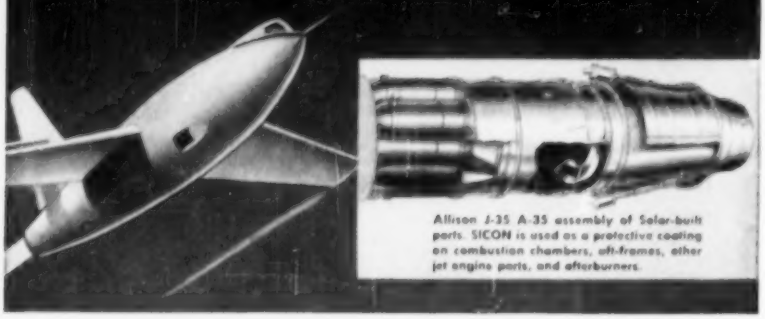

Allison J-35 A-35 assembly of Solar-built parts. SICON is used as a protective coating on combustion chambers, aft-frames, other jet engine parts, and afterburners.

Operator masks end of combustion chamber with simple cardboard shields as he applies SICON finish to resist temperatures up to 800°F.

This J-35 afterburner shroud assembly has been masked at critical hole patterns and threaded attachments before being sprayed with SICON silicone coating.

HEAT RESISTANCE UP TO 800°F. *plus* EASY APPLICATION

An example of how SICON solves Finish Problems for Design Engineers.

Jet engine parts made by Solar Aircraft are fabricated from special aluminized steel to meet conditions of extremely high temperatures. Certain welding operations destroy the aluminized surface, and at such critical points SICON was first adopted as a touch-up finish to renew vital protection needed. SICON proved stable under searing heat tests due to its strong film adhesion and excellent heat resistance characteristics, also so easy and fast to apply that many parts are now given an all-over SICON coating.

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INSTITUTIONAL NEWS

Theoretical papers of lasting interest in the field of basic Chemical Engineering can be found in the September and December issues of the *A.I.Ch.E. Journal*. The topics included are:

• SEPTEMBER •

Absorption and Distillation: Measured Plate Efficiencies and Values Predicted from Single-phase Studies; Evaluation of the Heat Requirements in Batch Distillation Operations.

Diffusion and Mass Transfer: Graphical Solution of Turbulent-flow Diffusion Equations; Gas Mixing in a Square Duct; Thermal and Material Transfer in Turbulent Gas Streams; Local Transport from Spheres; Effects of Bubbling and Stirring on Mass Transfer Coefficients in Liquids; Effect of Liquid Physical Properties and Flow Rates on the Surface Area of Sprays from a Pressure Atomizer.

Heat Transfer: Nusselt Values for Estimating Turbulent Liquid Metal Heat Transfer in Non-circular Ducts; Heat Transfer Coefficients for Condensing Organic Vapors of Pure Components and Binary Mixtures; Studies on Effective Thermal Conductivities in Packed Beds.

Drying: Drying of Sand on a Hot Surface.

Fluid Flow: Interaction Between a Turbulent Air Stream and a Moving Water Surface; Discharge Coefficients through Perforated Plates; Two-phase Pressure Drops in Large-diameter Pipes; Two-phase, Steam-water Critical Flow; Behavior of Suspended Particles in a Turbulent Fluid.

Mixing: Simple Theory of an Idealized Turbulent Mixer.

Kinetics: Equilibrium Ratios of Hydrogen and the Critical Loci of Hydrogen-paraffin Mixtures.

Catalysis: Catalysis Effect of Water Vapor on the Catalytic Oxidation of Nitric Oxide; Catalyzed Gas-liquid Reactions in Trickling-bed Reactors; Determination of the Chemical Properties of an Oxide Catalyst in a Closed System.

Physical Properties: Surface Tension of Acetone-water Solutions up to Their Normal Boiling Point; Critical Constants of the Aromatic Hydrocarbons.

• DECEMBER •

Chemical Kinetics: Kinetics of Aldehyde Hydrogenation; Reaction of Porous Solids.

Fluid Flow: Axial Mixing in Pipes; Motion of Spheres and a Fluid in a Cylindrical Tube; The Distribution of Eddy Viscosity and Mixing Length in Smooth Tubes; Velocity Profile for Fully Developed Turbulent Fluid Flow in a Pipe; Continuous Flow Stirred Tank Reactors.

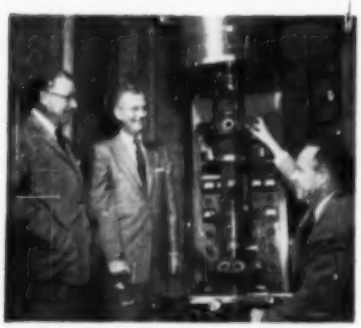
Diffusion and Mass Transfer: Diffusion Coefficients in Hydrocarbon Systems Meth...e-n-Heptane; Mass Transfer Between Two Liquids with Chemical Reaction.

Separation: Prediction of Cake Washing Results with Continuous Filtration Equipment; Hydroextraction: Flow in Submerged Cakes; Continuous Centrifugation in a Disk Centrifuge.

Heat Transfer: Thermal Conductivity-Reduced State Correlation for the Inert Gases; Unsteady State Heat Transfer in Stationary Packed Beds; Thermal Resistance of an Eddy.

Thermodynamics: Vapor-liquid Equilibria and Heat of Mixing in the Ternary System n-Octane-Ethylbenzene-Cellosolve and Three Related Binaries; Vapor-liquid Equilibrium Data for the Ternary System Cyclohexane-Heptane-Toluene; Heats of Vaporization of Hydrogen Bonded Substances.

Copies of this quarterly journal of the chemical engineering profession are available from the office of the Institute at 25 West 45 Street, New York 36, N. Y.



An electron microscope has been presented to the University of Akron Institute of Rubber Research by the Goodyear Tire & Rubber Co. Shown with the instrument are Maurice Morton (right), director of the Institute; R. P. Dinsmore (left), Goodyear, vice-president for research and development; and Norman P. Auburn (center), president of the U. of Akron.

Development of a new type of smog sampling equipment will be carried out by the Research and Development Dept. of Pittsburgh Coke & Chemical under a contract awarded it by the U. S. Public Health Service. Pittsburgh Coke says that their scientists will aim at 99 per cent or better sampling efficiency in collecting most air contaminants for analysis. □

Research on high-purity anhydrous titanium trichloride, now being produced in semicommercial quantities by Stauffer Chemical, indicates that the compound may prove to be of particular interest as a reducing agent in the manufacture of fine organic chemicals and pharmaceuticals. □

An advanced model electron probe microanalyzer, designed and built at Battelle Memorial Institute, has just been placed in service at the Columbus, Ohio research center. Able to isolate for analysis a region less than 1/10,000 of an inch in diameter (2½ microns) on any specimen being studied, the new tool is expected to be particularly valuable in exacting analyses of metals, ceramics, and chemicals. □

Substantial expansion of facilities for chemical and biochemical research has been announced by Chas. Pfizer & Co. A new research building (see artist's sketch above), located near the company's plant at Groton, Conn., is scheduled for completion late in 1959.

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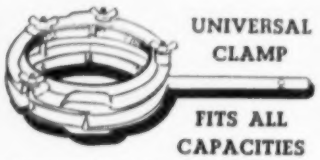

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■ 1958 MEETINGS

• Wilmington, Del., February 3-4, 1958. Hotel DuPont. **I.S.A. Chemical and Petroleum Industry Symposium on "Progress and Trends in Chemical and Petroleum Instrumentation."** Advance registration forms from Bill Durkin, Fischer & Porter Co., 2011 Concord Pike, Wilmington 3, Del.

• Chicago, Ill., March 17-21, 1958. **1958 Nuclear Congress.** Managed by A.I.Ch.E. Coordinated by E.J.C. Will include: 4th Nuclear Engineering and Science Conference, 4th International Atomic Exposition, 6th Atomic Energy in Industry Conference, 6th Hot Laboratories and Equipment Conference, and the American Power Conference.

• Brooklyn, N.Y., April 8-10, 1958. Engineering Societies Building, New York, N. Y. **Annual International Symposium of Microwave Research Institute of Brooklyn Polytechnic.** Subject—"Electronic Waveguides."

• Montreal, Canada, April 20-23, 1958. Sheraton-Royal Hotel. Joint A.I.Ch.E.-C.I.C. Conference. A.I.Ch.E. CHAIRMAN: Kenneth Beatty, North Carolina State College, Raleigh, N. C. CO-CHAIRMAN: W. H. Gauvin, McGill University, Montreal. **Chemical Engineering Aspects of Heavy Water Power Reactors**—CHAIRMAN: Donald Stuart, Evaluation Section, Civilian Power Reactors Branch, A.E.C., Washington 25, D. C. CO-CHAIRMAN: W. M. Campbell, Canadian A.E.C. **Chemical Engineering Methods in Mineral Processing**—CHAIRMAN: L. A. Roe, Int. Minerals and Chemical Corp., Chicago 6, Ill., CO-CHAIRMAN—F. A. Forward, University of British Columbia, Department of Mining & Metallurgy, Vancouver 8, B. C. **Fluid Mechanics**—CHAIRMAN: S. G. Mason, Dept. of Chemistry, McGill Univ., Montreal, P. Q. **Noise in the Chemical Industry**—CHAIRMAN: G. Thiessen, Physics Division, National Research Council, Ottawa, Ontario. **Chemical Engineering in the Pulp and Paper Industry**—CHAIRMAN: L. R. Thiesmayer, Pulp and Paper Research Institute of Canada, 3420 Univ. St., Montreal, P. Q. **Future Sources of Energy**—CHAIRMAN: J. W. Hodgins, Director of Engineering Studies, Hamilton College, McMaster Univ., Hamilton, Ontario. **Modern Engineering Construction Techniques**—CHAIRMAN: S. A. Guerrieri, Lummus Co., 385 Madison Ave., New York 17, N. Y. **High Temperature Materials for Jets and Rockets**—CHAIRMAN: Charles Marsel, New York University, New York, N. Y. **Statistics in Chemical Engineering**—CHAIRMAN: J. C. Whitwell, Princeton University, Princeton, N. J. **General Papers (2 sessions)**—CANADIAN CHAIRMAN (pro tem): W. H. Gauvin, Dept. of Chemical Engineering, McGill Univ., Montreal, P. Q.; AMERICAN CHAIRMAN: H. Donnelly, Wayne University, Detroit, Mich. Special panel discussion (Sunday afternoon, April 20, 1958)—**Chemical Engineering Education in the United States and in Canada**—MODERATOR: W. G. Whitman, Dept. of Chemical Engineering, M.I.T., Cambridge, Mass. International Luncheon (Tuesday noon, April 23), SPEAKER: Lester Pearson. **Round Table Discussion** (following luncheon) on **"What the Investor Looks for in Chemical Management and What Management Looks for in Investments."**

• Namur, Belgium, June 10-13, 1958. **First International Congress on Vacuum Techniques,** sponsored by Commissariat General of the Belgian Government with the Brussels 1958 International and Universal Exhibition. Further information from Professor E. Thomas, c/o CSN/ERM, 30, Avenue de la Renaissance, Brussels 4, Belgium.

• Berkeley, California, June 19-21, 1958. Dwinelle Hall, University of California. **1958 Heat Transfer and Fluid Mechanics Institute.** Sponsored by Calif. Institute of Tech., Stanford Univ., University of Calif., Univ. of Santa Clara, Univ. of Southern Calif., A.I.Ch.E., Amer. Rocket Society, A.S.M.E., Amer. Society of Refrigerating Engineers, Institute of Aeronautical Sciences, Society of Automotive Engineers. Papers on fundamental aspects of heat transfer and fluid mechanics. GENERAL CHAIRMAN: A. K. Oppenheim, Mechanical Engineering, Univ. of Calif., Berkeley, Calif.

• Philadelphia, Pa. June 22-27, 1958. Bellevue-Stratford Hotel. A.I.Ch.E. Fiftieth Anniversary Meeting. CHAIRMAN: Roy Kinckiner, DuPont, Wilmington, Del. Theme for program is: **A Look to the Future.** All symposia and papers are being planned in ac-

(Continued on page 98)

SOUTHERN NEVADA SECTION SCHEDULES ONE-DAY MEETING FOR JANUARY IN LAS VEGAS

Chemical engineers are sure to profit from their visit to Las Vegas January 18. Unlike similar recent one-day symposia, participants at next January's all-day symposium on electro-chemistry, corrosion, and instrumentation, sponsored by the **Southern Nevada Section** of A.I.Ch.E., will not have to make the awful choice between which one of two or three simultaneous panels they want to attend. Papers will be presented one at a time and in sequence in accordance with the schedule listed in the accompanying program breakdown.

ELECTROCHEMISTRY

Electrochemistry, Charles W. Tobias, University of California at Berkley.

Mercury Cells, A. Basilevski, North American Solvay, Inc.

CORROSION

Fabrication and Uses of Glass-lined Steel and Tantalum, J. W. Koehler, Pfaudler Sales Co.

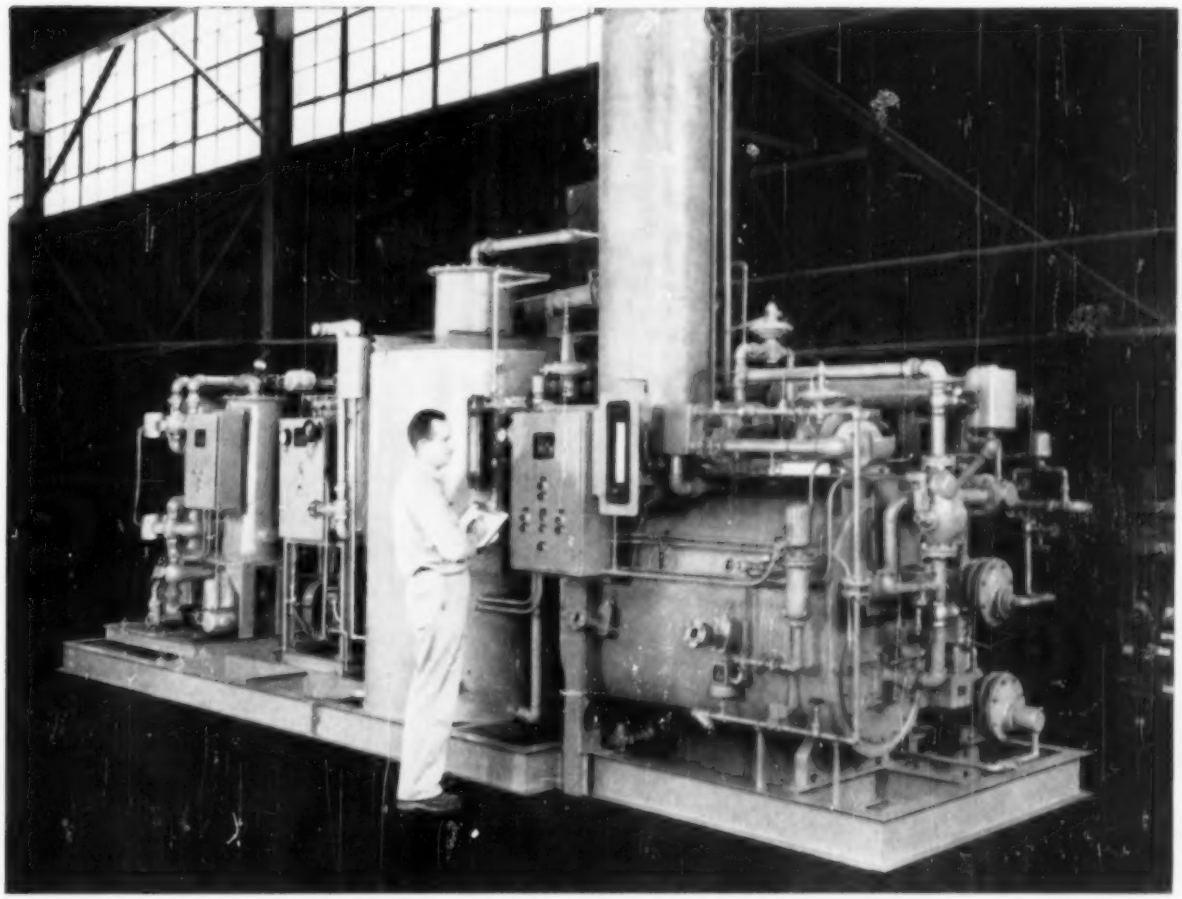
INSTRUMENTATION

Process Gas Chromotography Analysis, Stan Spracken, Beckman Instruments, Inc.

Evaporator Controls, Steve V. Kerstner, Foxboro Co.

Instrumentation of a Bauxite Reduction Plant, Emory Feree, Minneapolis-Honeywell.

Process Design for Automatic Control, J. G. Ziegler, Taylor Instrument.



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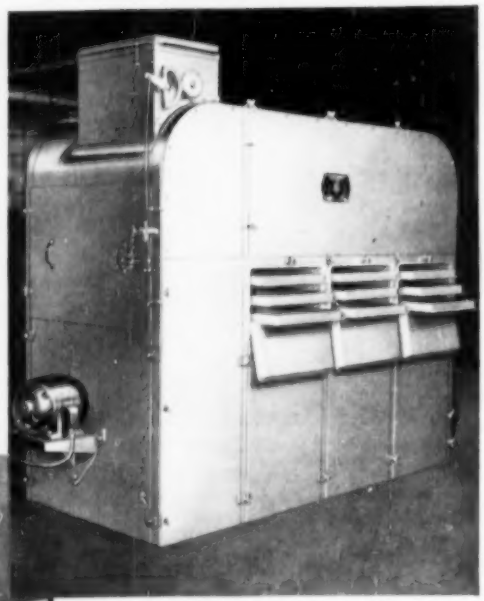

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future meetings

(Continued from page 96)

cordance with this theme. **Fluid Mechanics, Heat and Mass Transfer**—Organizer: C. R. Wilke. **What Does the Future Hold?**—Organizer: William J. Borns, Socony Vacuum Oil Co., Paulsboro, N. J. **Education of the Chemical Engineer**—CHAIRMAN: F. M. Tiller, Univ. of Houston, Cullen Blvd., Houston 4, Texas. **Salaries of Professors**—Organizer: not yet named. (See story on page 110.)

• Evanston, Ill., August 18-21, 1958. A.I.Ch.E.-A.S.M.E. Heat Transfer Conference, Northwestern U. Technological Inst. CHAIRMAN: A. S. Foust, Dept. of Chem. Eng., Lehigh University, Bethlehem, Pa.

• Salt Lake City, Utah, Sept. 21-24, 1958. Hotel Utah. A.I.Ch.E. National Meeting. CHAIRMAN: E. B. Christiansen, Dept. of Chem. Eng., Bldg. 437, Univ. of Utah, Salt Lake City. **Air Pollution**—CHAIRMAN: W. L. Faith, Air Pollution Foundation, 704 S. Spring St., Los Angeles 14, California. **What's New in Liquid Metals Technology**—CHAIRMAN: Marshall Sittig, American Lithium Institute, Inc., P.O. Box 549, Princeton, N. J. **Crystallization**—ORGANIZER: C. S. Grove, Jr., Director of Engineering, Syracuse Univ. Research Institute, Syracuse 10, N. Y. **Foams and Froths**—ORGANIZER: J. Louis York, Dept. of Chemical Engineering, Univ. of Mich., Ann Arbor, Mich. **Ethylene**—ORGANIZER: Hermann C. Schutt, 201 Devonshire Street, Boston, Mass. **Polar-Nonpolar Thermodynamics**—CHAIRMAN: J. M. Smith, Dept. of Chem. Engr., Northwestern Univ., Evanston, Ill. **Petroleum Substitutes**—CHAIRMAN: J. M. Hirsch, Gulf Research & Dev. Co., P. O. Drawer 2038, Pittsburgh 30, Pa.

• Cincinnati, Ohio, December 7-10, 1958. **Netherland Plaza Hotel. A.I.Ch.E. Annual Meeting. TECHNICAL PROGRAM CHAIRMAN: A. C. Brown, Emery Industries, Inc., June & Long Streets, Ivorydale, Ohio. Liquid Pollution**—C. Fred Gurnham, Dept. of Chem. Eng., Michigan State U., East Lansing, Michigan. **Distillation**—CHAIRMAN: W. C. Schreiner, M. W. Kellogg Co., 711 Third Ave., New York 17, N. Y. **High-Speed and Time-Lapse Photography in Chemical Engineering**—CHAIRMAN: J. W. Westwater, William Albert Noyes Laboratory, Univ. of Illinois, Urbana, Ill. **Kinetics & Rate Processes**—CHAIRMAN: H. E. Hoelscher, Dept. of Chem. Eng., John Hopkins Univ., Baltimore 18, Md. **New Approaches for Commercial Chemical Development**—CHAIRMAN: H. E. Wessel, Monsanto Chemical Co., 1700 South Second Street, St. Louis, Mo. **Reprocessing of Fluid Reactor Fuels**—CHAIRMAN: O. E. Dwyer, Chemical Engineering Division, Brookhaven National Laboratory, Upton, L. I., N. Y. **The Application of Computers to Heat and Mass Transfer Problems**—CHAIRMAN: J. M. Smith, Northwestern Univ., Evanston, Ill. **Low Temperature Processing**—CHAIRMAN: C. McKinley, Air Products, Inc., Allentown, Pa. **Applied Heat Transfer**—CHAIRMAN: Not yet appointed. **Scale-up from Pilot Plant to Plant**—CHAIRMAN: D. B. Coghlan, Foote Research and Development Laboratories, Berwyn, Pa. CO-CHAIRMAN: R. A. Schulze, DuPont, Chambers Works, Jackson Labs., Penns Grove, N. J.

■ 1959 MEETINGS

• Kansas City, Mo., May 10-13, 1959. TECHNICAL PROGRAM CHAIRMAN: Fred Kurata, Chemical Engineering Dept., Univ. of Kansas,

(Continued on page 100)

News from
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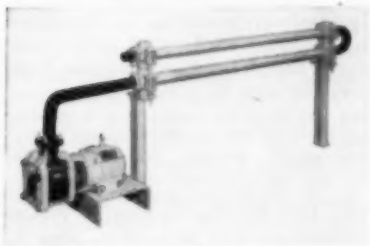

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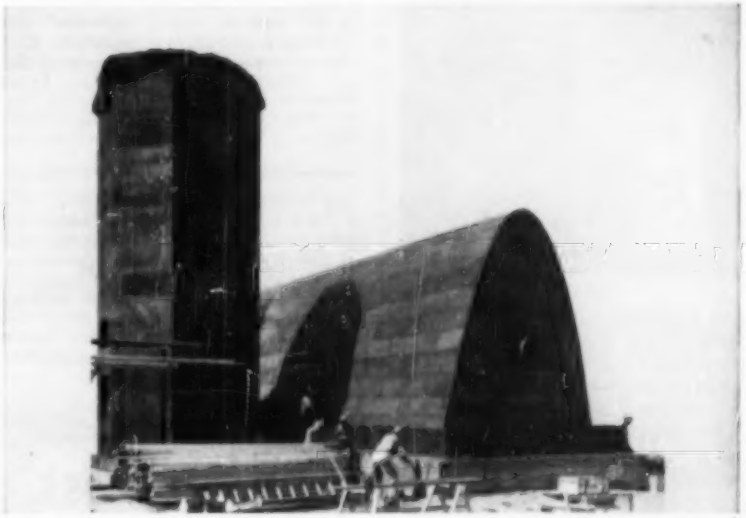
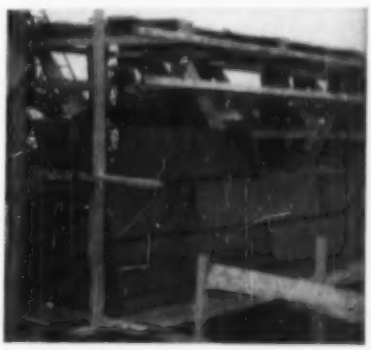


This installation has one of the largest capacity combustion chambers ever built. Made of graphite, the burner chamber (on right) and the carbon hydrator tower (on left) produce phosphoric acid from elemental phosphorus for the Shea Chemical Co. of Jeffersonville, Ind.

Corrosion resistance and structural stability at high temperatures make carbon and graphite invaluable in combustion chambers, reactor vessel linings, bubble cap trays and packing support structures. Virtually immune to thermal shock, and with little expansion under heat, carbon and graphite can be used in reducing atmospheres up to 3000°C. Furthermore, high thermal conductivity enables water-cooled graphite structures to withstand up to 2000°F under oxidizing conditions.

Easily machined to close tolerances, carbon and graphite can be worked even by hand tools. Depending on size and process requirements, the materials can be supplied for either monolithic or segmental structures. Segmental structures have been built with walls 20′ long x 15′ high, using blocks 7½″ thick, 28½″ wide and 72″ long.



After a carbon or graphite structure is completed, shoring is removed. Special high joint-strength cement with essential properties of carbon and graphite bonds the blocks or slabs.

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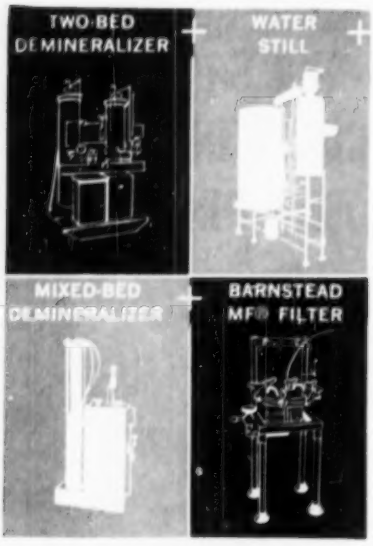

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future meetings

(Continued from page 98)

Lawrence, Kansas. **Reaction Kinetics**—CHAIRMAN: R. R. White, Dept. of Chem. Engr., Univ. of Michigan, Ann Arbor, Mich. **How to Become a More Proficient Technical Engineer**—CHAIRMAN: not yet chosen. **Heavy Chemicals**—CHAIRMAN: not yet chosen.

• London, England, Summer 1959. Symposium on **"Instrumentation and Computation in Process Development and Plant Design."** Sponsored by Institution of Chemical Engineers, Society of Instrument Technology, and the British Computer Society. Information from Institution of Chemical Engineers, 16 Belgrave Sq., London, S.W. 1.

• San Francisco, Calif., December, 1959. TECHNICAL PROGRAM CHAIRMAN: C. R. Wilke, Division of Chemical Engineering, Univ. of California, Berkeley, Calif. **Process Dynamics**—CHAIRMAN: E. F. Johnson, Dept. of Chem. Engr., Princeton Univ., Princeton, N.J.

—S.O.S.—

The Roundtable Discussions held at recent A.I.Ch.E. National Meetings have enjoyed such wide popularity that the Program Committee has decided to emphasize this type of get-together at other meetings in the near future. Suggestions for topics are needed badly and will be welcomed with open arms. Ideas should be sent to E. R. Smoley, Asst. Program Chairman, A.I.Ch.E., Lummus Co., 385 Madison Ave., New York 17, N. Y.

UNSCHEDULED SYMPOSIA

Proposed, but unscheduled, symposia of the Institute may be found listed in November *CEP*, page 180. Correspondence on proposed papers is invited by the symposia chairmen.

Summer Institutes on Nuclear Energy, jointly sponsored by ASEE and AEC, will be held again in the summer of 1958. Of special interest are projected specialized institutes of metallurgy, reactor theory and design, chemical processing, and instrumentation. Applications will close in January, selection of participants will be made in February or early March, 1958. □

The Yankee Instrument Fair & Symposium, sponsored by the Boston Section, I.S.A., will take place at the Hotel Bradford, Boston, January 14 and 15, 1958. Information and registration forms are available from I.S.A., Boston Section, Inc., Box 282, Boston 1, Mass. □

The 13th Purdue Industrial Waste Conference will be held on May 5, 6, and 7, 1958, in the Purdue Memorial Union Building, Lafayette, Indiana. Approximately fifty papers will be presented on industrial wastes and their treatment. □

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With T-E Miniature Gasket Thermocouples

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In Canada—THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

The Reinforced Plastics Division of The Society of the Plastics Industry will hold its 13th Annual Technical and Management Conference in Chicago on Feb. 4, 5, and 6, 1958. Conference and an Industry Exhibit will be at the Edgewater Beach Hotel and will be open to non-members as well as members of the Society. The "new and improved" (in materials, test results, quality controls, and processing techniques) is the basic theme of the 3-day, 18-session program. This year, emphasis will also be placed on relating the advances to end-use industries. □

The Seventh Annual Instrument Short Course will be held Jan. 30 and 31, 1958, at the Los Angeles Harbor Junior College, Wilmington, Cal. The course will have basic technical papers, sessions on practical methods, and exhibits. □

An Engineering and Management Course, from January 27 to February 6, 1958, is offered by the University of California, Los Angeles. Information on registration, course material, and living accommodations is available from Edward P. Coleman, University of California Extension, Engineering, Los Angeles 24, California. □

Origin, nature, and action of antibiotics will be the theme of an exhibit sponsored by a group of U. S. antibiotics manufacturers at the forthcoming 1958 Brussels Universal and International Exhibition, April 17 to October 19, 1958. Chief American contributors are Chas. Pfizer & Co., Lederle Laboratories, American Cyanamid, Ely Lilly & Co., Merck Sharp & Dohme International, and Parke, Davis & Co., each of which has given $10,000 towards the project. □

A graduate program in nuclear engineering, day and evening courses, will start in February, 1958, at the Chemical Engineering Department of the Engineering School of Pratt Institute, Brooklyn, New York. Included will be problems of nuclear reactors, isotope processing, production of radioactive materials, fuels and wastes, and industrial applications of atomic energy. □

An entirely new trade exhibition, the Chemical and Petroleum Engineering Exhibition, will be staged in London in the summer of 1958. Special attraction for visitors will be a conference on "The Organization of Chemical Plant Construction Projects," organized by the Institution of Chemical Engineers. □

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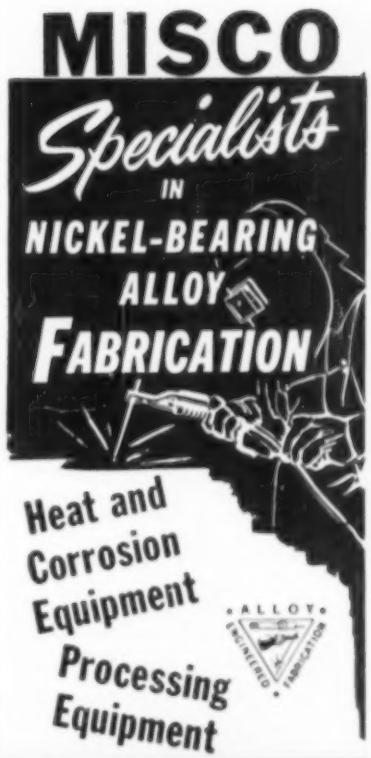

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news from local sections

PROVOCATIVE PROGRAM AT NEW YORK SECTION ONE-DAY MEETING

- **Proposed legislation could put some chemical engineers out of business.**
- **A choice spot in the parking lot is not sufficient reward for creative contributions.**
- **Although higher mathematics are needed too, engineers could make better use of the mathematical tools they already have.**

In a hard-hitting group of symposia at the recent one-day meeting of the New York section, speakers examined chemical engineering aspects of current problems connected with professional licensing, legal angles of the practice of engineering, and the growing importance of automatic process control.

Professional Engineering

"Of the five major engineering societies, chemical engineers hold the lowest number of professional licenses," says F. Johnson, president of the N.Y. State Society of Professional Engineers."* It is conceivable that if the more rabid elements among professional engineers have their way, proposed legislation to make licensing compulsory might leave some chemical engineers with no legal basis to charge consulting fees. "Before such legislation is put in the works, it is imperative," continued Johnson, "that chemical engineers establish the requirements for their own professional status and recognition." Joseph F. Lawrence, symposium chairman, stated that present law is out of date. There is no law requiring chemical engineers, specifically, to take the P. E. exam; if they do there is very little in the exam pertinent to chemical engineering. He suggested that "If the current side-stepping of the exam persists, because of this inadequacy, it may perhaps be in order to suggest that graduate and post-graduate equivalency levels be established which would automatically qualify the holder of such a graduate-level degree for the status of licensed P.E. Perhaps some minimum time requirement—say five years plus M.S., with a decreasing time for further degrees —might be a suitable criterion. In any event, some positive stand should be made, subject to later amendment as experience dictated." Civil and mechanical engineers have already made approaches to the solution of this problem, according to Lawrence. He emphasized, however, that enactment of professional engineering legislation should not be the result of a "lobby" type operation: "After establishing a basis for professional status, publicity should be used to apprise legislators, licensing bodies, and the general public of what chemical engineers feel must be the minimum effort to attain professional status.

"This specification of minimum standards is of the utmost importance, both with respect to an ethical level of performance quality and the general safety of the overall community. It is particularly true in the New York area, where there are a number of small chemical companies, that too many of the boss' relatives with a couple of hours of technician-type training are being passed off as engineers."

Legal Aspects of Knowledge

That chemical engineers are not fully aware of their contractual obligations to their employers was pointed out to those attending the symposium on Legal Aspects of Knowledge presided over by Bertel Greffrath. One result of the symposium was the general agreement that the legal aspects of engineering creativity should be included in engineering curricula.

"The present laws governing employer-employee relationships are simply a philosophy based on historical

(*Continued on page* 104)

* At Symposium on Professional Engineering, one-day meeting of New York Section, A.I.Ch.E., October 22, 1957.

Wearing a Texas hat presented by the South Texas section is A.I.Ch.E. President J. H. Rushton. At the section's regular monthly dinner meeting the prominent "mixer" described the Institute's program of providing a professional environment for chemical engin..rs through the sponsorship of publications, national and local meetings, educational standards for chemical engineering curricula, and the important committee functions of the Council. To his left in the usual order are: D. G. Schroeter, South Texas Section chairman; C. P. Fitzgerald, chairman-elect; and Seaton Hunter, Monsanto.

USE OF MODELS IN PLANT DESIGN; SAFETY TRAINING FEATURED AT SOUTH TEXAS MEETING

"The use of scale models is gaining ground, not only because they provide a three-dimensional layout of a prospective plant, but because the finished models can be used for operator training, for public relations, and for construction at the actual plant site." This was one of the conclusions of Fluor speaker A. E. Michel at the 12th* Annual Technical Session of the South Texas Section of A.I.Ch.E.

There are many technical difficulties which must be overcome in building models, and not all plant design problems are suited to solution by the use of models. When design by model is used intelligently, however, and engineering drawings are made only after the "bugs" have been designed out of the model, many man-hours of design, drafting and revision time, and resulting bales of unnecessary drawings can be eliminated.

As an example of the value of the model technique, Michel cited a saving by Fluor of a quarter of a million dollars in drafting costs during the past year, while maintaining the same volume of business, even though the entire cost of constructing the models was charged against drafting.

Fluor feels that it will only be a matter of time before the industry will look upon the model as being as much a part of the job as are specifications and drawings. That this is no idle speculation is borne out by current advertising which features fully-scaled, push-fit models with the ". . . ultimate objective . . . the most efficient design of better refineries and chemical plants."

(*Continued on page* 107)

* One day session of South Texas Section A.I.Ch.E. held October 18, 1957 at Galveston.

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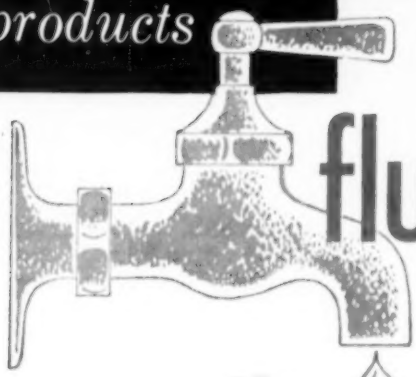

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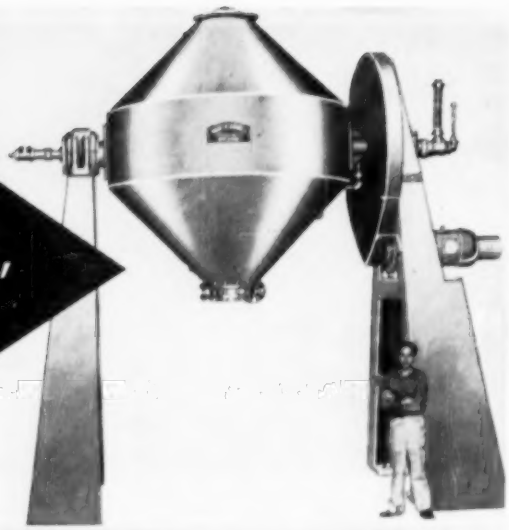

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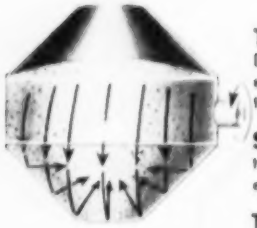

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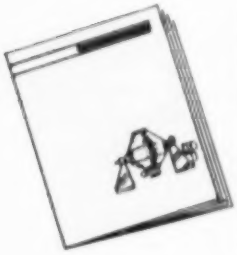

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news from local sections

ONE-DAY IN NEW YORK

(Continued from page 102)

precedents—such concepts not being mathematically demonstrable," said E. Willey, patent counsel of Flintkote Co. "Most law decisions are based on whether or not the facts presented for argument are contrary to public interest. The court protects the engineer as an individual as long as he negotiates reasonable contracts. If the facts are "stacked" in a particular engineer's favor—that is, if he is taking unfair advantage of a favorable set of circumstances—he would be likely to lose a judgment," continued Willey.

A major point brought out in the symposium is the importance of an engineer's realizing how much industry depends upon his integrity, and how much he, in turn, depends on the integrity of industry. "An engineer cannot legally be prohibited from taking another position similar to his previous jobs," said Willey, "but he would be committing professional suicide if he made unethical use of his prior knowledge to the benefit of subsequent employers. This is an example of legal rights based on public 'sentiment,' for such an individual would be blacklisted with respect to any future employment."

Taking a stand for the engineer's intellectual liberty, Willey noted that "creative people require freedom for courageous, uninhibited thinking. This is the type of thinking given free rein in brainstorming sessions, where the individual can put forth his ideas without fear of reprisal should his proposals fall on antagonistic ears. This courageous thinking is characteristic of the creative genius; that is, he is capable of using novel approaches to problem solutions, he functions differently from those around him who operate by rote, and is able to express himself without fear of repercussion should his suggestions not be to the liking of the dictator of company policy."

The consensus of the symposium speakers was that, in present-day industry, the engineer's genius is appreciated but is not satisfactorily rewarded. Among the subtler means of showing appreciation for the abilities of the creative employee, as described by R. A. Norton, attorney for American Cyanamid Co., is such a seemingly unimportant item as providing choice parking facilities in the company parking lot. In some measure this *does* set this particular employee

(Continued on page 106)

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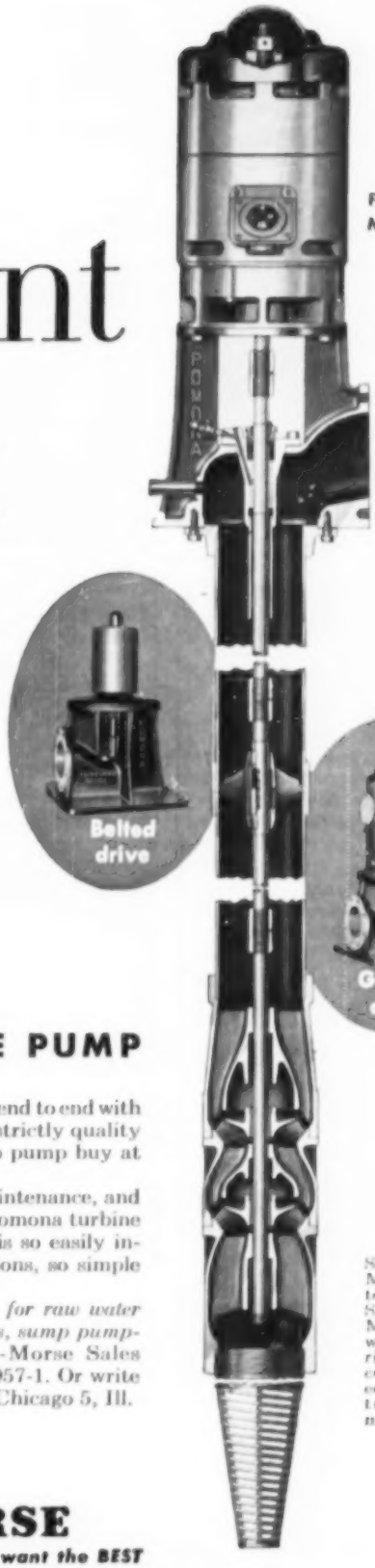

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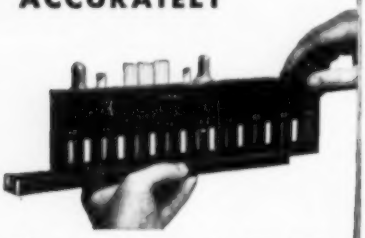

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news from local sections

ONE-DAY IN NEW YORK

(*Continued from page 104*)

apart, agreed D. A. Rudkin of Merck & Co., but only creates jealousy among others not so favored. Pursuing this question of 'rewards,' according to Willey, although the engineer's inventions are recognized as of value to the company, "such recognition is not generally expressed in terms of promotions and reimbursements, but usually only in terms of a certificate. Such scanty expression of gratitude tends to stifle the flow of greater inventive effort."

"When engineers realize that their developments are being given suitable notice," said symposium chairman Greffrath, "they tend not to 'sell' the advantages of their profession to others who might normally be of a mind to pursue such an occupation, thereby contributing in some respect to the current 'shortage of engineering personnel'—not so much by design, as by lack of interest."

Control Engineering

E. F. Johnson, professor of chemical engineering at Princeton, in the Control Engineering symposium observed that, "the aim of our technology is to increase the productivity of our invested capital and our labor without limit. We seek nothing less than fully automatic, continually-optimized plants, industry, and economy. . . . Further," he continued, "while the 'art' of control engineering has served us in the past, the increasing interest in high-speed reactions and processes, and the continuing battle to reduce investment requirements and operating expenses make it increasingly important that a precisely quantitative consideration of the control problem become a vital part of any projected plant study or design."

Johnson also noted that the teaching of chemical engineering has become preoccupied with unit operations; that a reevaluation is necessary for a better balanced perspective. In addition to the usual questions a chemical engineer asks in his problem solving process (What physical or chemical limitations are imposed on the process involved? What amounts of material, energy, and money are involved? What types and sizes of equipment are required?), Johnson feels that the engineer must also question the quality of performance expected. The answer to each of these

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questions is based on a particular concept: thermodynamic equilibrium, conservation, rate process (kinetics), and control. Only recently has the latter been of interest to chemical engineers. It has two aspects: economic control and process control.

Historically, according to Johnson, the development of control theory stems from the early researches of Nyquist into the defining differential equations for feedback amplifiers and investigations of communications and circuit theory. Progress in the application of theory was accelerated by World War II research into frequency response analysis for the development of fire control and similar positioning systems, and it was perhaps the formidability of this mathematical approach that dissuaded chemical engineers from any creative activity in the field of process control. Today, however, differential equations are included in most chemical engineering curricula, and this amount of mathematics is sufficient for the understanding of control principles.

Although there is some sentiment for adding a further course to include operational calculus, statistics, and courses on a similar plane, Johnson feels, however, that it would perhaps be better to learn to use more effectively the mathematical tools already possessed by chemical engineering students. Automatic process control affords an excellent opportunity for this. A major course in control given in the senior year could integrate many diverse disciplines, could tie together the loose strings in the curriculum.

AND A DAY IN HOUSTON

(Continued from page 102)

Early signers at the more-than-800 record registration for the South Texas one-day Technical Meeting are John McKetta, newly-elected Director of A.I.Ch.E., Kenneth Kobe of the University of Texas, and George Gibbs, Gulf Publishing Co.

Well-known is the complexity of modern plant layouts. Because of this, *maintenance* is becoming more important, more specialized, and therefore more expensive. The maintenance-

(Continued on page 108)

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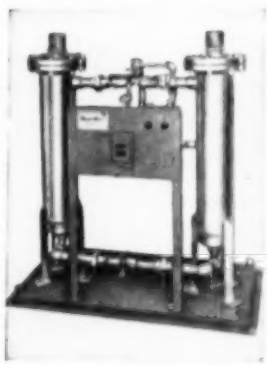

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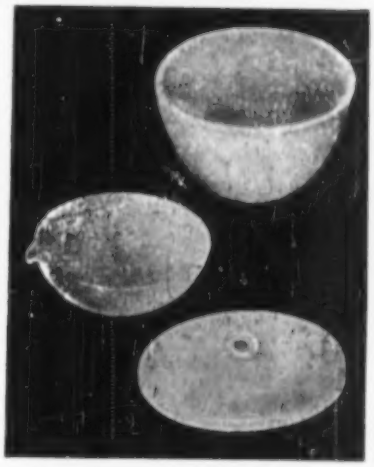

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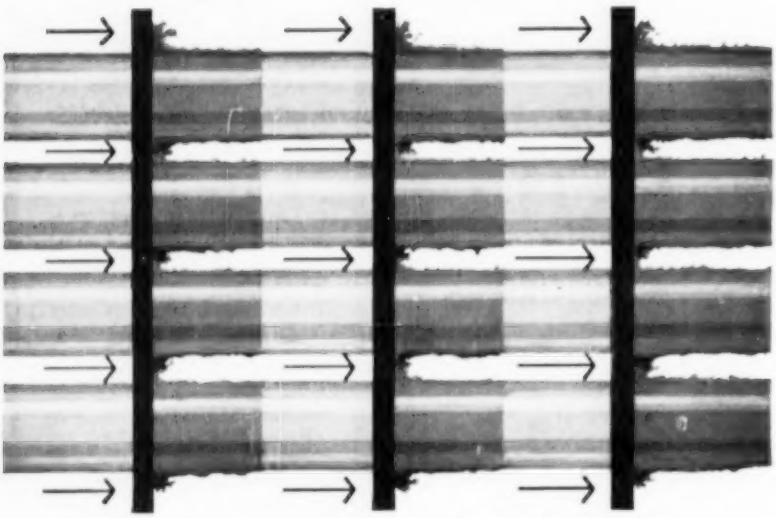

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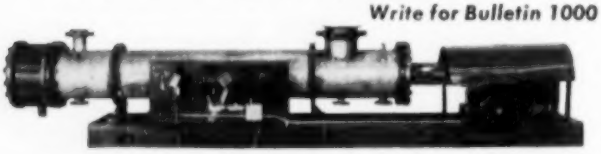

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news from local sections

A DAY IN HOUSTON

(Continued from page 107)

labor payroll of du Pont has increased twice as much as "all other" wage rolls since the base year of 1940. This was reported by O. S. York of DuPont at the Maintenance and Construction Symposium of the meeting. York emphasized, however, that it is not the increased cost of maintenance that should be reckoned, but rather the over-all *operating cost*, which has been proven to have been lowered because of the efficiency resulting from the dexterous performance of complex maintenance operations.

A 12% increase in effectiveness was achieved at DuPont through better employee job knowledge and morale. This increase in efficiency was brought about by on-the-job training, the objective being to assist employees to "work smarter, not harder." By thus 'wising up' maintenance mechanics ". . . idle time is reduced, because jobs are better planned and scheduled, material is available when needed, and better tools are developed and provided," said York.

A proper training program not only provides an increase in employee efficiency through specific knowledge for the proper maintenance of facilities, but also results in improvements in safety performance. "A trained mechanic is ten times as safe as the untrained mechanic," commented York.

Training applies equally well in the case of safety, according to L. J. Grossheim, of Shell Oil: "Knowing how to handle an emergency situation *at the time it happens* can only be the result of adequate prior preparation. Planning for, and being prepared for, disaster may be the means for saving millions in terms of lives and property damage. This is acutely in the minds of Gulf coast chemical engineers since [1957] is the tenth anniversary of the Texas City disaster. Plant safety is only one of the many possible areas open to beforehand planning. A well-organized plant safety program, integrated with local civil officials, with uniform *modi operandi* and a dependable means of group communication, is imperative where large scale chemical processing operations and storage of potentially dangerous materials are routine. Being prepared is invaluable not only for natural calamities, or man-made accidents, but also for an all-out atomic attack."

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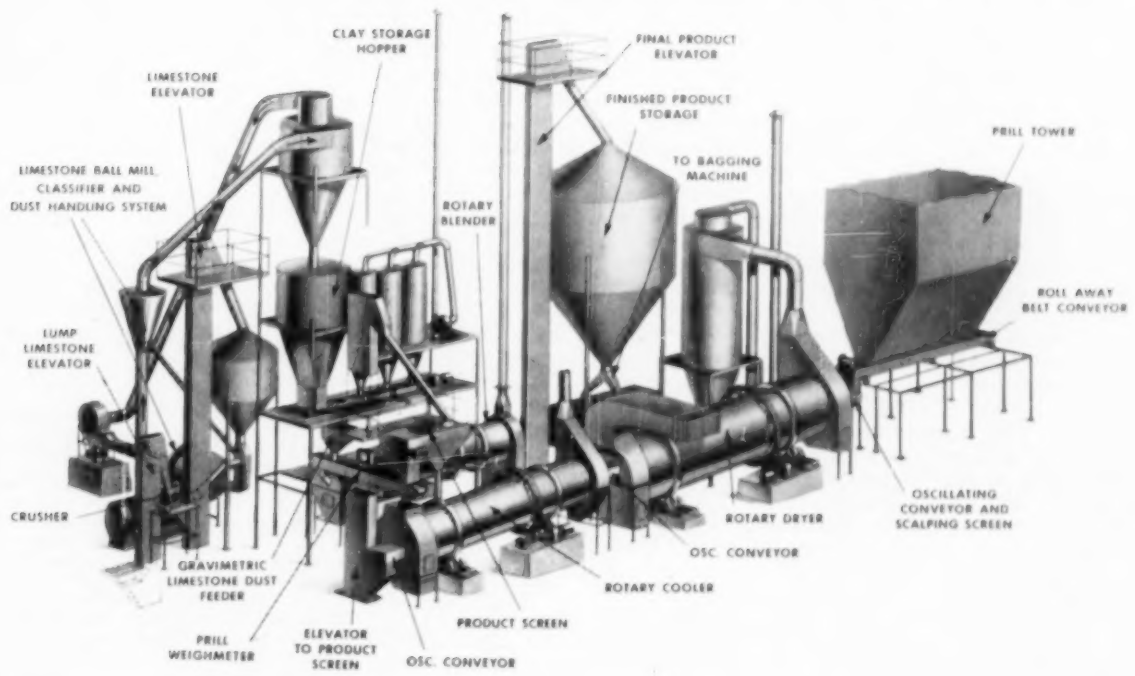

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Urea prills having an initial moisture content of 2% to 3% are fed out of the prill tower — dried — cooled — screened — and weighed. After adding coating material in proper proportion the prills are passed through a blender to assure even, thorough coating. The finished prills are then conveyed to storage ready for delivery to the bagging machines. The major equipment units are mounted on one level for easy operation. The system is wholly enclosed, and kept under slight negative pressure to prevent dust loss. Fines are collected, and dissolved, in wet type dust collectors, and the liquor passed back to the prill tower for re-processing.

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JUBILEE!

A.I.Ch.E.'s Fiftieth Anniversary Celebration will take place in Philadelphia, Pennsylvania the week of June 22-27, 1958.

The year 1958 promises to go down in history as eventful for mankind. One of the events contributing to this end result will be the coming of age of chemical engineering as a profession. This will be exemplified by a week-long 50th Anniversary Jubilee—a program of ceremony, dedication, review, and a long look to the future.

The City of Brotherly Love will play host to chemical engineers from all over the world, many as official delegates. All will bear—besides good tidings which are a part of anniversaries—ideas which, when exchanged with their fellows from other places, will represent an important contribution to improved international understanding. Thus it may well be demonstrated by hundreds—even by thousands—that chemical engineering, originally conceived and nurtured in the fertile resources of America, has come to be truly international in character.

The origin of the A.I.Ch.E. will be the subject for much ceremony and discussion. The event took place in the Engineer's Club, a small building characteristically Philadelphian in architecture, located on an out-of-the way narrow street in the downtown district. In this same building, a dedication ceremony on January 29, 1958 will unveil a bronze plaque to be installed on one of the walls.

Headquarters hotel for the Jubilee will be Philadelphia's stately Bellevue-Stratford. Some events will take place elsewhere.

The Post Office Department is understood to be considering the issuance of a special commemorative stamp for the occasion. At press time, no definite word had been received relative to the outcome of the application which was made with the enthusiastic backing of leaders in education and industry.

Memorial Volumes

Three volumes of unusual interest are in final stages of preparation and will soon be on press for sale at the Jubilee. One of these will be *Chemical Engineering Around the World*, edited by Edgar L. Piret of the University of Minnesota. It is made up of a collection of more than 50 chapters written by outstanding authorities in that many countries. From the quality of the material received, it is already apparent that this volume will be unique in much of the information it will contain. As a ready reference source on the more recent developments of note, as well as resumés of future potential for the application of chemical engineering techniques, it is quite definite that nothing like it exists. One of the most interesting contributions is from the Soviet Union, in which will appear, in detail, resumés of discovery complete with names of technologists involved, dates, etc.

Two volumes will document the history and use of chemical engineering in United States industry. They are under the editorship of W. T. Dixon, Atlantic Refining, and A. W. Fisher, Jr., A. D. Little, Inc., and are made up of chapters contributed by various leaders in selected fields. These will be arranged according to industry categories. Volume I will cover ten of these, and Volume II twelve.

Awards

Awards, including a special medallion created for the occasion, will be presented or distributed to outstanding personages. The design for the commemoratory medallion shows a stylized human figure kneeling with bowed head, the fingers of the right hand digging into the earth, symbolizing resources, and the left arm extending out and upward, palm up. On the palm stands a miniature distillation column and storage sphere, symbolizing processes and products. A beam of sunlight strikes the back of the head and the outstretched arm, leaving the face in shadow. The design is based on a suggestion by Robert L. Rorschack, winner of the recent Symbol Contest.

The slogan used on the medallion is "Science and industry in the service of man," suggested by Clay Lewis. Lewis was winner of the Slogan Contest. The slogan will be widely used on literature and publicity in connection with the Jubilee.

The Program

In forthcoming issues of *CEP*, plans for the general program and the technical program (see *CEP*, May, 1957, p. 126), will be unfolded. The May, 1958 issue of *CEP* will be devoted to emphasizing and commemorating the 50th Anniversary Jubilee and will dwell on the theme of the technical program: *A Look to the Future*.

Chemical engineers and their wives would do well to begin planning now for what may be one of the richest experiences in their association with the practice of chemical engineering. From the quality and numbers of people lending their support and presence to this forthcoming Jubilee event, it should be apparent that such an opportunity for association and inspiration may not soon again be experienced.

MCA TO LEND SUPPORT TO 50TH ANNIVERSARY PROGRAM

The Manufacturing Chemists' Association will help direct attention to chemical engineers, chemical engineering achievements, and the A.I.Ch.E. during MCA's 1958 Chemical Progress Week, and throughout the year. This will be under the aegis of MCA's new Chemical Industry Activities Committee program. At its September meeting, the MCA Board of Directors approved resolutions designating April 14-18, 1958, as Chemical Progress Week and endorsed cooperation with A.I.Ch.E.'s 50th Anniversary program.

At the present time, MCA public relations headquarters is developing material for distribution to its local committees throughout the country. Included will be a speech on the chemical engineer and his contributions to mankind. Also, since Chemical Progress Week activities will be generated at these local levels, M.C.A. is strongly recommending that each committee establish contact with its nearby A.I.Ch.E. section to discuss ways and means of bringing in the 50th Anniversary story. M.C.A. headquarters plans to follow up this program through monthly bulletins. Meanwhile, the Association is working with the Institute Public Relations Committee to arrange contacts between their members and A.I.Ch.E. local chairmen.

There will be much that Institute local sections can do to promote effective public relations during Chemical Progress Week, taking advantage of M.C.A.'s machinery, personal support, and the national attention Chemical Progress Week has gained. Local Public Relations Chairmen will be receiving details from A.I.Ch.E.'s national committee in the near future.

The American Institute of Chemical Engineers announces the

GOLDEN JUBILEE of CHEMICAL ENGINEERING

To be celebrated
June 22 through June 27
at Philadelphia, Pennsylvania
Birthplace of the A.I.Ch.E.

PLAQUE CEREMONY TO OPEN OBSERVANCE OF INSTITUTE'S FIFTIETH BIRTHDAY

To commemorate its founding in 1908, the A.I.Ch.E. will unveil a plaque at the Engineers' Club of Philadelphia on January 29, 1958. This choice of site is highly appropriate, as the Engineers' Club of Philadelphia was the scene of important formative meetings prior to the official founding of the Institute in June, 1908.

In addition to commemorating the birth of the A.I.Ch.E., the plaque will stand as a lasting tribute to the foresight of the founders of the A.I.Ch.E. and the continuing progress of chemical engineers and chemical engineering. The dedication meeting will thus serve to get the A.I.Ch.E.'s Golden Jubilee Year off to an auspicious beginning.

The plaque will be dedicated by George G. Holbrook, president elect of the A.I.Ch.E., and manager of the Elastomer Chemicals Department of du Pont. Following the presentation of the plaque, the meeting will be addressed by a representative of the City of Philadelphia; Harry W. Pierce, president of the Engineers' Club; Raymond P. Genereaux, a director of the A.I.Ch.E.; and Dr. Holbrook.

A.I.Ch.E. Plaque Dedication at Engineers' Club of Philadelphia

Place: 1317 Spruce Street
Philadelphia, Pennsylvania

Time: January 29, 1958
Social Hour .....5:30 PM
Dinner .....6:30 PM

For reservations contact:

William R. Lucas
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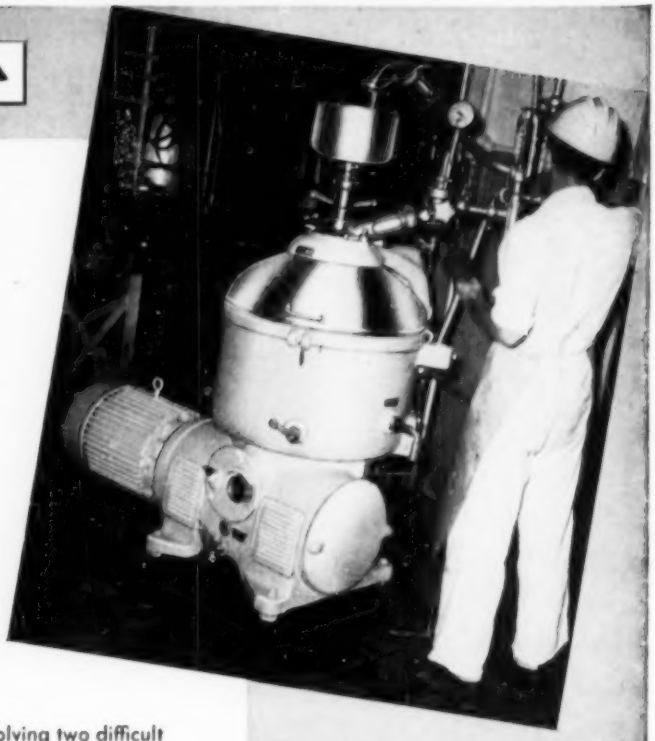

Suppose you developed an extraction process involving two difficult liquid-solid separations, where the specific gravities of the phases were very close to one another? Faced with this tough problem, engineers at famed Lederle Laboratories chose a WESTFALIA KG-10006 Clarifier. So pleased are they with its efficient performance, that Lederle engineers call the WESTFALIA KG "the best machine on the market for this type of production."

At Lederle, the WESTFALIA KG first clarifies an acid colloidal suspension. The pH of the retained liquid is adjusted for optimum precipitation conditions. A precipitating agent is added to floc out valuable solids. Clarifying the new suspension, the WESTFALIA KG runs uninterruptedly for eight hours, and recovers about 150 pounds of solids per run. By utilizing a second set of bowl inserts, downtime can be reduced to as little as 20 minutes!

The record-breaking efficiency of the WESTFALIA KG is due mainly to the unique design of its extra-large six-chamber bowl. Unlike other clarifiers which have a single tubular bowl – and which lose efficiency rapidly as soon as the solid cake begins to build up – the WESTFALIA multi-chamber bowl runs many more hours before shutdown is necessary — and its efficiency is just as high at the end as it is at the start of a run.

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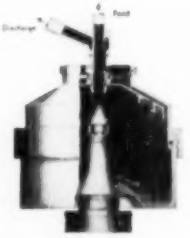
Have You Thought of a KG Clarifier in YOUR Industry?

- **CHEMICAL** – Clarification of caustics and other textile processing solutions, acetate and latex solutions, solvents, glue, india rubber solutions, ink. Recovery of catalysts.
- **PHARMACEUTICAL** — Clarification of insulin, serum, plant and animal organ extracts and bacteriological cultures.
- **FOOD** — Clarification of sugar syrups, vegetable and fruit pulp, butter color, coffee extract, cocoa butter, vinegar, essences, meat and yeast extracts, gum arabic.
- **OIL PROCESSING** — Polishing of mineral and vegetable oils. Clarification of petroleum, cutting and grinding oils, dry fats.
- **PAINT AND VARNISH** – Clarification of resin and oil varnishes, lacquers, shellac, chlorinated rubber, enamels, and linseed oil.



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SASOL: chemical engineering abroad

New South African gasoline-from-coal plant is outstanding example of technical and human engineering achievements.

Whenever an American engineering-construction firm undertakes a first major process industry project for one of the less developed regions abroad, a number of political, economic, and cultural problems are invariably encountered. A project of this type which may be the diplomatic classic for some time to come is SASOL, M. W. Kellogg's full-scale gasoline-from-coal plant now operating at Sasolburg, a plant-community 50 miles south of Johannesburg, South Africa. In recently addressing an audience of chemical engineers * on the nature of the problems encountered and some of the measures developed to overcome them, W. B. Johnson, Kellogg's project manager of administrative engineering, said, "Some of the officials in South Africa were at first afraid of all sorts of intangible consequences . . . by carefully studying the factors involved and meeting them with rather unique procedures created especially for the occasion, we have seen these problems disappear, one by one. Now they have a plant they are proud of, being well operated by local people, and I'm sure they feel that an American firm did the job better than they thought would be the case, no matter who undertook it. . . ."

When Kellogg first began surveying the project the S.A. Government wanted them to undertake, it soon became apparent that the following would constitute unusual problems requiring solution:

- S.A. population difficulties and regulations, the latter particularly as applied to persons entering the country to work on the plant project, as these had to meet the requirements of stringent immigration laws.
- The existence in S.A. of a complex, mixed system of measures derived from various systems introduced in the past.
- The almost complete lack of technically trained individuals in S.A. in sufficient numbers to provide the usual local supplement to the contractor's engineering and construction staffs, and to serve as a source for plant operating personnel.

To meet these challenges, Kellogg began by studying, with the S.A. Government, the technical manpower supply. In a country where the engineering graduate population is relatively low (a mere 161 in 1946), and semi-technical manpower availability is complicated by the internal problems, Kellogg and the S.A. Government decided to solve the manpower impasse by recruiting in Europe. Technical personnel and their families were contacted in Germany, France, Holland, Denmark, and England, and screening centers were set up to assure the acquisition of competent personnel—those desirable to Kellogg and acceptable to S.A. should the families wish to remain—immigration laws and all else being considered.

A construction manager plus 22 engineers and craft foremen were assigned from the United States. About 500 skilled artisans were recruited and screened, mainly from Germany, Denmark, the Netherlands, Great Britain, Belgium, and France, and their entire families flown to Sasolburg. Living conditions and schools were provided for this international group.

South Africans from the farms, high schools, and secondary industries were trained for supplementing the foreign construction force and as plant operators. This was done by Kellogg's task force and 12-man operating team, in conjunction with German experts installing German "Arge" synthesis units. Since the plant demanded new techniques of operation, it was necessary for the Kellogg operation team to spend four months in the New York office with the force assisting in the preparation of operating manuals prior to leaving for S.A. The plant's maintenance department has been drawn from the S.A. construction force. Successful as was this extensive recruiting and screening program, Kellogg now knows that the South Africans themselves learned and mastered the technical details and operation of the synthetic gasoline plant so rapidly and well that were a similar venture to be undertaken again in S.A. (and Mr. Johnson suggested this probability) more local manpower could be trained on the spot.

No newcomer to the overseas market for U.S.-design process plants, Kellogg grossed $68 million in overseas construction and $15 million in Canada over a two year period up to December 1956. "With this project," continued Johnson, "we were not dealing with a large oil or chemical company, but with a government-sponsored organization which had no previous experience and was obviously to grow with the job." In fact, when Kellogg made its first contacts with SASOL, "the organization consisted of the managing director and three engineers. Today the employees number some 2 to 3 thousand. This was a development project in every sense of the word."

Coal to Gasification of Oil

The mission of SASOL is to solve the problem of South Africa's abundant and cheap (60¢/ton) coal reserves in relation to a deficit oil supply. By now this, the first large-scale, commercial oil-from-coal plant, has proven its design capacity or better, according to Mr. Johnson. SASOL is now running at stream efficiencies of from 70 to 75 per cent. The improving of operating efficiency through the correction of mechanical difficulties is now the only major task preventing the plant from meeting the design capacities of about 55 million imperial gallons per year. The large production of hydrocarbon chemicals (phenol is already being exported to Holland) is also a factor in the economic success of the process and an expansion of this aspect would make the over-all project even more successful. The conversion of coal to raw synthetic gas (CO and H_2) from steam and oxygen is estimated to cost 7¢/thousand cu.ft. and 12¢/thousand cu.ft. for purified synthesis gas after allowing for amortization, etc. The coal used comes from an adjacent mine of 24-foot seam thickness, and the plant itself produces 92-93 octane gasoline selling at retail for one cent per gallon below regular grade imported gasoline. "So far," commented Johnson, "the plant has had no difficulty in meeting market demands . . . One ton of coal costing about 60¢ produces one barrel of product worth about $12."

Future of Oil-from-Coal Units

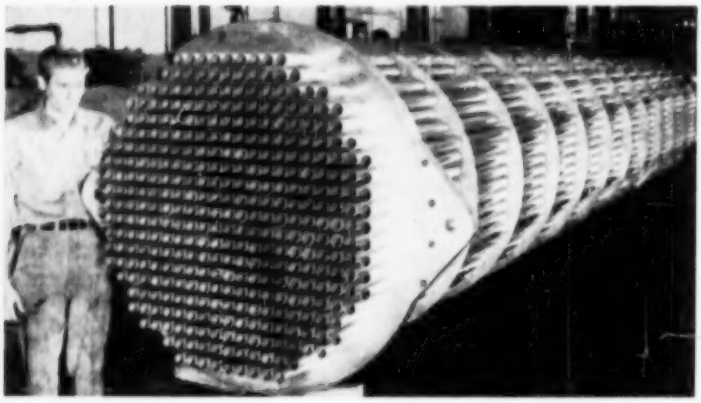
Countries with no developed oil reserves (England or Spain, for example) are said by Mr. Johnson to be studying the SASOL success. With atomic power at hand, England is predicted to have an excess coal supply shortly and gasification may well be the answer to provide still more energy for the industrial scene. The Scottish Gas Board recently considered the use of a gasification process for an open-pit coal area in the Westfield, Fife, region. If approved, the scheme would net production of 30 million cubic feet of gas per day for use in the immediate area, possibly including Glasgow and Dundee.

* At N.Y. Local Section A.I.Ch.E., November meeting.

CEP camera

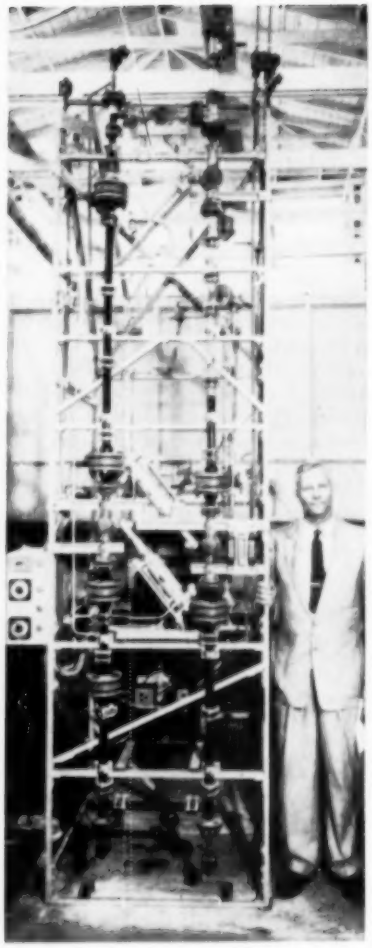
NEW ION EXCHANGE CONTACTOR

of the Higgins type has been delivered to Georgia Tech for research and teaching in radiological separations processes. The new unit, of one-inch glass pipe construction, is similar to those in use at Oak Ridge's Chemical Technology Division for R & D projects such as recovery of uranium from unfiltered ore leach pulps and recovery of cesium from fission product wastes. The second of its kind built and delivered by Chemical Separations Corporation this year, the contactor was described in *CEP* in the September 1956 issue (p. 353). (See also the discussion by W. A. Selke, "Granular Processes—Ion Exchange," p. 601 of this issue.)



ALUMINUM TUBE BUNDLE

for heat exchange units utilizes that metal's high thermal conductivity. Built by Henry Vogt Company, the 365-tube bundle fits inside the aluminum shell of an ammonia absorber cooler in a new fertilizer-from-natural-gas plant of Southern Nitrogen Corp. A completed cooler weighs 11,000 lb., is 28 ft. in length and 49 in. in diam. over the largest flange.



◄ ATLAS MISSILE TEST FACILITY

operated by Convair Division of General Dynamics is in Sycamore Canyon, northeast of San Diego, Calif. At lower left is the blockhouse and remote control center from which static missile tests at the nearby stand are conducted. Captive tests of the ICBM's complex systems and subsystems are conducted at Sycamore; flight test missiles are sent to the Air Force Missile Test Center at Cape Canaveral, Florida.

100-G CENTRIFUGE ►

is used by General Dynamics at San Diego to test components of the Atlas ICBM. Costing $450,000, the massive machine can whirl a one-ton load 121 rev./min. on the 10-ton, 40-ft. steel boom.

SHIPPINGPORT FACILITY GOES CRITICAL

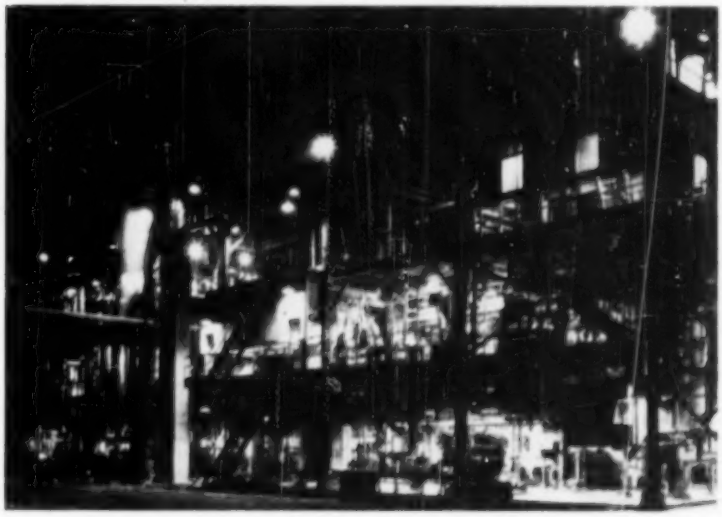
The nation's first full-scale nuclear power-generating station, on which construction began in March 1955, will mark the beginning of a new era in the peaceful uses of nuclear energy. Heat source at Shippingport is a pressurized water reactor. Water at 2,000 lb./sq. in. is heated to 545° F., is then pumped through heat exchangers which use the heat to boil condensate and generate steam at 600 lb./sq.in. to drive a 100,000 kw. Westinghouse turbine-generator. The fuel core for the reactor contains some 14 tons of natural uranium surrounding about 165 lb. of highly-enriched uranium "seed."

SPHERICAL REACTORS

destined for oil refinery service are loaded on barge for inland waterway delivery to Baton Rouge, Louisiana. The reactors, 17½ ft. in diam. and made of 1⅞-in. plate, were fabricated by Wyatt Metal & Boiler Works, Houston, Texas.

GLOWING IN THE DELTA DARKNESS

at Luling, Louisiana, Monsanto's new adipic acid plant is one of the country's major sources of this increasingly important dibasic acid. The new unit is integrated with the raw materials facilities of nearby Lion Oil, which recently merged with Monsanto.



CANDIDATES FOR MEMBERSHIP IN A.I.Ch.E.

The following is a list of candidates for the designated grades of membership in A.I.Ch.E. recommended for election by the Committee on Admissions.

These names are listed in accordance with Article III, Section 8 of the Constitution of A.I.Ch.E.

Objections to the election of any of these candidates from Members and Associate Members will receive careful consideration if received before January 15, 1958, at the office of the Secretary, A.I.Ch.E., 25 West 45th Street, New York 36, N. Y.

Member

• Banford, William H., *Lewiston, N. Y.* Barrington, James R., *Valparaiso, Ind.* Bevans, Rowland S., *New York, N. Y.* Booth, Thomas W., *Kingsport Tenn.* Boyer T. W., *Louisville, Ky.* Brown, Roy W., *Chillicothe, Ohio*

• Conjar, Lawrence N., *Pittsburgh, Pa.* Comiskey, Patrick T., Jr., *Jackson Heights, N. Y.*

• Dalman, P. G., *Wilmington, Del.* Dardoufas, Kimon, *Linden, N. J.* Davies, George F., *Alhambra, Calif.* Deacon, A. E., *Kansas City 5, Mo.* De Beausset, V. S., *Gross Ile, Mich.* De Lisle, Norman G., *Midland, Mich.* Dunn, Herman B., *Wichita, Kansas.*

• Easter, Robert J., *Durango, Mexico.* Eklund, Rolf B., *Sodertalje, Sweden.* Ellis, John F., *Lancaster, England.* Ewing, Lloyd, *Milwaukee, Wis.*

• Graves Harold E., *Midland, Mich.* Groppe, Henry, *Houston, Tex.* Gross, Pershing C., *Phillips, Tex.*

• Heitman, Joseph B., *Tacoma, Wash.*

• Johnson, William R., *Sheffield, Ala.*

• Kafka, David H., *Niagara Falls, N. Y.* Keller, David P., *Trenton, N. J.*

• Le Page, D. H. L., *Berkeley, Calif.* List, Harvey L., *Roselle, N. J.* Little, Thomas H., *Strafford, Pa.* Lyon, Robert E., *Munster, Ind.*

• Martin, F. J., *Port Neches, Tex.* McDaniel, Robert S., *Chicago, Ill.* McKinney, Dwight D., *Pittsburgh, Pa.* Mogensen, Allen O., *New Canaan, Conn.* Morrison, William G., *Phillips, Tex.*

• Pannill, J. K., Jr., *Kingsport, Tenn.*

• Rorschach, Robert L., *Tulsa, Okla.*

• Schillmoller, C. M., *Los Angeles, Calif.* Shoults, J. M., *Denver City, Tex.* Stephens, T. J. R., *Newark, Del.*

• Talalay, Leon, *New Haven, Conn.* Tormey, John F., *Woodland Hills, Calif.* Turnbell, Harold S., *Bethel Park, Pa.*

• Walker, John H., *Corpus Christi, Tex.* Watson, Eugene K., *Stamford, Conn.* Wrotnowski, Arthur C., *Glenville, Conn.*

Associate

• Aconsky, Leonard, *Westport, Conn.* Alber, Oleg, E., *Alexandria, Va.*

• Baldwin, Richard L., *Charleston, W. Va.* Barton, John T., *Freeport, Tex.* Best, Clem K., *Houston, Tex.* Beutler, Stanley A., *Newark, Del.* Bevers, Robert C., *New Orleans, La.* Bilgrei, Sheldon, *Bronx, N. Y.* Bliesner, William C., *San Francisco, Calif.* Bogart, William M., *Melrose Park, Ill.* Boyd, J. M., *La Marque, Tex.* Bradley, Paul Grant, *Buffalo, N. Y.* Bundy, Clifford L., *Casper, Wyo.*

• Campbell, William R., Jr., *Aiken, S. C.* Christensen, Robert I., *Richmond, Calif.* Clark, Le Roy P., *Ferndale, Mich.* Crews, Warren, *Sherman Oaks, Calif.* Crolius, Richard L., *Wauwatosa, Wis.* Cummer, William F., *Shreveport, La.*

• Daehnke, G. Theodore, *So. Charleston, W. Va.* D'Anieri, John E., *Schenectady, N. Y.* Dayan, Saul S., *Buffalo, N. Y.* Deakin, George R., *Corpus Christi, Tex.* Derenburger, William B., *Parkersburg, W. Va.* Dietsche, William O., *No. Tonawanda, N. Y.* Duwve, James R., *Toledo, Ohio.*

• Ellis, Enright A., *Portland, Oregon.* Epperly, W. R., *Roselle, N. J.* Estridge, Ronald B., *Appleton, Wis.* Evanko, Merle R., *Great Falls, Montana.*

• Fang, Frank, *Morristown, N. J.* Fisher, Wilbur E., Jr., *Army Chemical Center, Md.* Fooksman, Robert F., *Dayton, Ohio.* Forrester,

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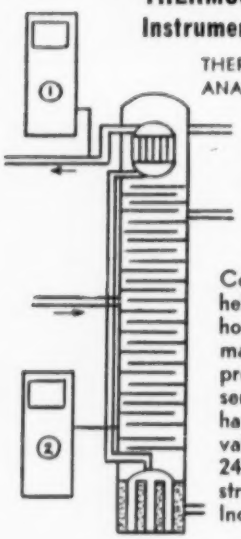

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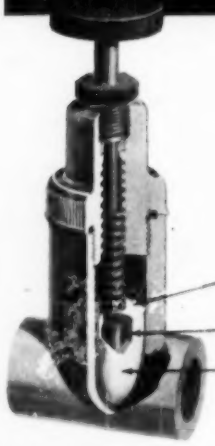

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- Handles wide range of corrosives and slurries

- Back-seating feature of cap: when valve completely open, relieves pressure on packing.
- Free-to-swivel plug: provides even wear of cap, perfect closure.
- Flexible synthetic cap: easily replaced without removal of valve from line; minimal maintenance. Handles abrasive slurries without wear.

- All-plastic design — PVC or styrene-copolymer. Replaceable caps available in Neoprene, Buna-N, and Hypalon (Kel-F elastomer on special order).
- Suitable for vacuum — resilient cap makes excellent seal.
- Adaptable to all existing plastic pipe and fittings; especially suited to Vanton P, S, and N lines of plastic pipe and fittings.
- Rated for 150-lb. service—PVC line up to 140°F., styrene-copolymer line to 170°F.

*Pat. Pending

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Frederic J., *Evanston, Ill.* Fredlund, Norton, *Minneapolis, Minn.* Friday, John R., *Baytown, Tex.* Fructuoso, Enrique, *Venezuela, S.A.*

• Gallant, Robert W., *Baton Rouge, La.* Geiser, Frederick J., *Baton Rouge, La.* Gregoli, Armando A., *Bloomfield, N. J.* Guigou, C. H., *Muskogee, Okla.*

• Hannah, James F., *Columbus, Ohio.* Hartley, Donald, *St. Joseph, Mich.* Harvin, Richard L., *Louisville, Ky.* Haxby, Robert D., *Cincinnati, Ohio.* Herbst, Thomas Wesley, *Pasadena, Tex.* Hess, K. William, *Richland, Wash.* Horgan, Donald W., *Towson, Md.*

• Johnson, Robert L., *Midland, Mich.* Jones, Maurice J., *Decatur, Ala.* Jordan, Dennis R., *Minneapolis, Minn.*

• Karp, Jerome, *Brooklyn, N. Y.* Kothari, Mohan Singh, *Baton Rouge, La.* Kunin, Robert, *Philadelphia Pa.*

• Lacy, Harold M., Jr., *Texas City, Tex.* Lamberson, Robert L., *Decatur, Ill.* Lay, William J., Jr., *Pensacola, Fla.* Ledene, Donald L., *New Hyde Park, N. Y.* Lee, Carroll W., *Corpus Christi, Tex.* Leland, Thomas W., Jr., *Houston, Tex.* Leschinsky, Abraham, *E. Paterson, N. J.* Lieber, Ronald H., *St. Louis, Mo.* Lindland, K. Paul, *Wilmington, Del.* Lorentzen, Peer, *Cincinnati, Ohio.* Lawnie, H. W., Jr., *Columbus, Ohio.*

•MacDonald, David H., *Brentwood, Mo.* MacFarlane, Frank P., Jr., *Millbourne, Pa.* Malloch, Charles D., *Overland, Mo.* Mantarro, Joseph, *Springfield, Mass.* Martin, Morgan, Jr., *Victoria, Tex.* Masse, Arthur N., *Calvert City, Ky.* Maurer, John Paul, *Oakland, Calif.* McKinney, William M., Jr., *Memphis, Tenn.* Meliere, Kenneth, *Howard Beach, N. Y.* Miles, Allen B., *Kingsport, Tenn.* Moller, William G., Jr., *Charleston, W. Va.* Mullen, Clarence, *Texas City, Tex.* Munson, John K., *Wilmington, Del.* Murphy, William J., *Upper Darby, Pa.*

• Nichols, James R., *St. Albans, W. Va.*

• Patterson, Leland W., Jr., *Pittsburgh, Pa.* Paul, Rajendra, *Trenton, N. J.* Penney, William H., *St. Paul, Minn.* Ping, A. Y., *Palmyra, N. J.* Pisciitell, Joseph F., *Syracuse, N. Y.* Prescott, Alwood A., Jr., *Lynchburg, Va.*

• Quinn, John, *Staten Island, N. Y.*

• Rockwood, Alan P., *Wilmington, Del.* Rosen, Irwin S., *East Meadow, L. I., N. Y.* Ruddy, Donald C., *Cheltenham, Pa.* Rump, Edward J., *Charleston, W. Va.* Russell, Thomas H., *Harper, Kansas.* Russo, Anthony S., *Houston, Tex.*

• Schowalter, W. R., *Princeton, N. J.* Schueler, Arnold P., *Belle, W. Va.* Schultz, Rogers H., *Texas City, Tex.* Sharp, Robert M., *Baytown, Tex.* Sherry, Howard S., *Grand Island, N. Y.* Shroff, Peter, *Whittier, Calif.* Shuster, Steve, *Windber, Pa.* Signorelli, Richard A., *Passaic, N. J.* Slenk, Carl P., *Tonawanda, N. Y.* Smith, Halwyn R., *Riverside, Calif.* Snyder, Charles F., *Baytown, Tex.* Spell, Jack E., *Bryan, Tex.* Sproul, Jay C., *Houston, Tex.* Starner, Bernard M., *New Kensington, Pa.* Stelly, Elry, *Texas City, Tex.* Stern, Milton, *Brooklyn, N. Y.* Stevens, Robert W., *Schenectady, N. Y.* Stewart, James R., Jr., *Shreveport, La.* Streeper, Ronald R., *Huntingdon Valley, Pa.* Sturges, Alan P., *Texas City, Tex.* Sweeny, Robert Francis, *State College, Pa.*

• Thomas, Leonard L., *Manhattan Beach, Calif.* Thompson, Thomas J., *Kingsport, Tenn.* Titus, Glenn M., Jr., *Coraopolis, Pa.* Tully, John, *Yonkers, N. Y.*

• Veber, Garry Verne, *Newton, Iowa.* Vedoler, B. Chris, Jr., *London, England.*

• Wade, Dennis E., *Texas City, Tex.* Warner, Douglass J., *Cambridge, Mass.* Weaver, John M., *Chicago, Ill.* Weissman, Y., *Rehovot, Israel.* Wheeler, Bert R., *Idaho Falls, Idaho.* Wilhite, W. Franklin, *Baytown, Tex.* Wilson, Lawrence V., *Bartlesville, Okla.* Windham, Donald M., *New Kensington, Pa.* Wissler, Eugene H., *Austin, Tex.*

• Yount, Clyde C., Jr., *Dixon, Ill.*

• Zaccaria, John S., *Pittsburgh, Pa.*

Affiliate Member

• Bauer, William G., *St. Louis, Mo.*

• Cranmer, Joseph W., *Ft. Wayne, Ind.*

• Fuller, Robert Ray, *Waverly, Ohio.*

• Gammill, A. M., *St. Louis, Mich.*

• Henry, Joel, *New York, N. Y.*

• Walling, Robert, *Brunswick, Ga.*

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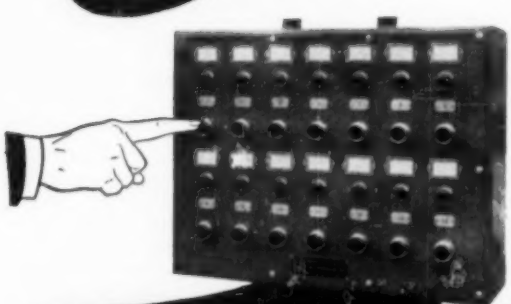

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MAJOR SCIENTIFIC SOCIETIES REPRESENTED AT NATIONAL UNESCO MEETING

Shown during the recent National Conference of the United States Commission for UNESCO at San Francisco are members of the "Asian-American Science Cooperation in the Southeast Asian Countries" work group. They are (left to right) Harold J. Coolidge, executive director, Pacific Science Board of the National Research Council; J. A. Samaniego, Shell Development Co. chemical engineer representing the A.I.Ch.E.; Dr. George P. Murdock, professor of anthropology, Yale University; and Dr. Thomas E. Hicks, associate professor of engineering, University of California.

Two Shell Development Co. scientists represented their respective societies at the recent National Conference of the U. S. National Committee for UNESCO (United Nations Educational, Scientific, and Cultural Organization) held in San Francisco in November. **J. A. Samaniego** represented A.I.Ch.E., while **D. B. Luten** was present for A.C.S. Theme of the meeting was "Asia and the United States: What the American Citizen Can Do to Promote Mutual Understanding and Cooperation."

Samaniego, long active in the affairs of A.I.Ch.E. and of the San Francisco Engineering Council, was co-author of a recent *CEP* article "Cost Estimation in the Development of a New Process" (November 1956, p. 471.) Luten, a chemist, completed a two-year assignment to the National Resources Section of General Headquarters of the Supreme Commander for the Allied Powers in Japan from 1948 to 1950.

William J. Kroll, consulting electrochemist-metallurgist of Corvallis, Oregon, and developer of the basic Kroll process used for producing metallic titanium and zirconium, has been chosen to receive the 1958 Perkin Medal of the American Section of the Society of Chemical Industry. Presentation of the medal to Dr. Kroll is to follow a dinner in his honor at the Waldorf-Astoria Hotel, New York City, January 10, 1958.

Kroll

Donald B. Schrock has been promoted to senior technical man at the Calvert City, Kentucky plant of B. F. Goodrich Chemical Company. Former senior design engineer at B. F. Goodrich's Louisville, Kentucky plant, **Henry H. Striby** has now been appointed supervising engineer.

Irwin Frankel, formerly senior engineer in the research and development department of Crown Cork and Seal Co., joins Olin Mathieson Chemical Corp. as chief technologist in the High Energy Fuels Organization.

New project engineer on the staff of Badger Manufacturing Co. is **Arthur J. Kessler.**

Myrle M. Perkins joins Bechtel Corp., San Francisco, as executive engineer. Perkins, who has been associated with M. W. Kellogg, New York, for the past 21 years, will be active in business development.

T. Q. Eliot has joined the technical division of Texas Butadiene & Chemical Corporation in Houston, where he will assist in process design, economics, and new project evaluation.

New director of the reactor engineering division at Argonne National Laboratory will be **Bernard I. Spinrad.**

Paul K. Kuroda of Fukuoka, Japan, has joined the staff of the radiological physics division of Argonne National Laboratory, Lemont, Illinois, as associate chemist. Kuroda will be studying problems of low-level radioactivity, such as the occurrence of strontium-90 in nature and in bone.

One of the founders and a past chairman of A.I.Ch.E. Toledo Section, **Joseph R. Scalzo,** has been elected to the city council of Toledo, Ohio. Scalzo is assistant chief chemical engineer for Sun Oil, Toledo Refinery. (See *Letters to Editor*, p. 8, this issue.)

Scalzo

Fessenden

L. Daniel Fessenden has joined Pfaudler at Rochester, N.Y. to do consultant work on agitation and mixing equipment.

Corning Glass announces six organization changes in the chemical services department: **R. D. Smith** has been appointed consulting engineer; **Frank Day** will succeed R. D. Smith as manager of the chemical services department, including the metallurgical staffs; **Ralph E. Miller,** supervisor of analytical chemistry, will be responsible for chemical analysis of raw materials and glasses in the melting operations; **Martin Klein, Jr.,** has been appointed to the newly created position of supervisor of batch economics and control; **Thomas J. Carpenter** has been named supervisor of chemical engineering services; and **Robert H. Close,** supervisor of instrumental analysis, is now in charge of spectrographic and X-ray analysis.

Tracerlab, Inc. of Waltham, Mass., announces the appointment of **Paul A. McNulty** as administrative assistant. McNulty will work in close conjunction with projects on new instrumentation, medical research, and Tracerlab's new Reactor Monitoring Services Program.

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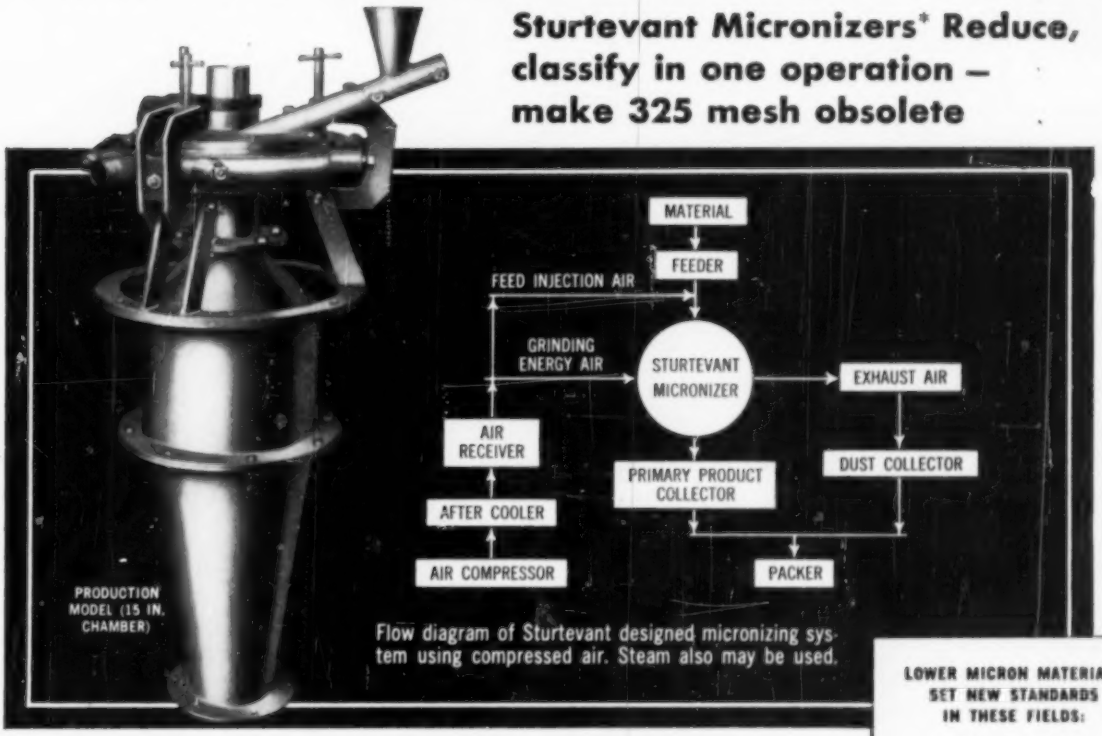

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A 30 in. Sturtevant Micronizer is reducing titanium dioxide to particle size under 1 micron at a feed rate of 2250 lbs. per hr. For another firm, a 24 in. model grinds 50% DDT to 3.5 average microns at a solid feed rate of 1200 to 1400 lbs. per hr. A pharmaceutical house is using an 8 in. model to produce procaine-penicillin fines in the 5 to 20 micron range. Iron oxide pigment is being reduced by a 30 in. Micronizer to 2 to 3 average microns at rates of 1000 lbs. per hr. Sturtevant Engineers will help you plan a Fluid-Jet system for your ultra-fine grinding and classifying requirements. *Write today.*

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Over 6" to 12" Inclusive	3/8"	168" maximum, 24" minimum
Over 12" to 14" Inclusive	7/16"	168" maximum, 24" minimum
Over 14" to 20" Inclusive	1/2"	180" maximum, 48" minimum
Over 20" to 24" Inclusive	1/2"	88" maximum
Over 24" to 32" Inclusive	5/8"	80" maximum

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people
(management & technology)

(Continued from page 118)

A former president and chairman of the board of trustees of the Mellon Institute, **Edward R. Weidlein** of Pittsburgh, has been named chairman for special and corporate gifts of the American Chemical Society's three million dollar building fund campaign. Mr. Weidlein, a former president of A.I.Ch.E., will organize the solicitation of gifts from corporations, foundations, etc., to establish a fund for the construction of a new eight-story ACS building in Washington.

Rowland

Union Carbide announces the appointment of **K. H. Rowland** as vice-president for production of Union Carbide Chemicals Co., division of Union Carbide Corporation.

The new operations research department of the A. E. Staley Manufacturing Co. will be headed by **George N. Cornell.** Succeeding Cornell as chief chemical engineer at Staley will be **Nat Kessler.**

William E. Keppler named project engineer with Merck Sharp & Dohme International Division, New York. Keppler was formerly production control manager at Merck's Cherokee plant in Danville, Pa.

New associate technical director of Union Carbide Development Co. is **Harry L. Willard.**

Camp

E. Q. Camp and **J. C. Schiller** have been promoted to assistant division heads in the Research and Development Division at Humble Oil & Refining Company's Baytown, Texas refinery; **S. R. Bethea, M. R. Morrow, M. A. Mosesman,** and **E. E. Zerwekh** have been named section heads in the same division.

Schiller

David E. Schoeffel joins the Research Department of Monsanto Chemical's Plastics Division, Springfield, Mass. Schoeffel has been with the division since 1952.

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people
(management & technology)

(Continued from page 120)

Ralph W. Eberly has been appointed manager of the Schutte and Koerting Company Instrument Division. He will assume responsibility for engineering, production, and marketing of the company's line of rotameters, flow indicators, and related products.

Eberly

Atlantic Research Corporation, a major subcontractor in the IGY Project Vanguard Earth Satellite Vehicle program, announces the addition of **Joshua S. Bowen, Jr.**, to its chemical engineering group.

Randolph Antonsen is to be the director of the newly-formed New Products Research and Development Department of the Godfrey L. Cabot carbon black and chemicals manufacturing firm in Boston.

Davison Chemical Co. organizes new development planning department with **O. D. Myrick, Jr.**, as director.

DEFENSE AWARD TO PFIZER

At the Chas. Pfizer headquarters in Brooklyn a delegation of two generals and two flag officers from the Armed Forces awarded the firm the Department of Defense Reserve Award on October 16. **John E. McKeen,** president of Pfizer, accepted the award given for "outstanding cooperation with the Armed Forces Reserve" by Major General Raymond E. Bell, chief of the U. S. Army Military District, N. Y.

Shown at the ceremony are (left to right): Major General John H. Ives, chief of staff, Continental Air Command; General Bell; Rear Admiral Milton E. Miles, commandant, 3rd Naval District; Rear Admiral Henry C. Perkins, commandant, 3rd Coast Guard District; Mr. McKeen, and Lieutenant Colonel Henry Strunk, 1st Marine Corps Reserve and Recruitment District.

Edson

Thomas F. Edson has been named plant manager of the Linden, N.J. plant of the Dyestuff and Chemical Division of General Aniline & Film Corporation.

The University of Cincinnati's McMicken College of Arts and Sciences announces the appointment of **Roger Chalkley** as instructor in mathematics.

Arthur C. Herrington has joined the staff of the Whiting Research Laboratories of the Standard Oil Company of Indiana.

Colgate-Palmolive Co. announces election of **John R. Brown, Jr.**, as director and vice-president in charge of research and development. Brown was formerly vice-president for research and development of Spencer Chemical Co.

John C. Hunt is appointed a section head in the chemicals development division of Esso Research and Engineering Company, Linden, N.J. **John F. Johnson** has been named a section head in the chemicals research division.

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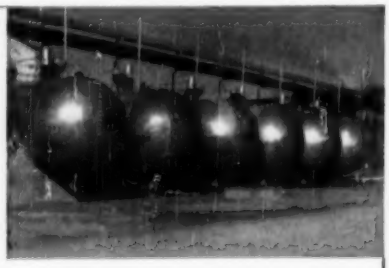

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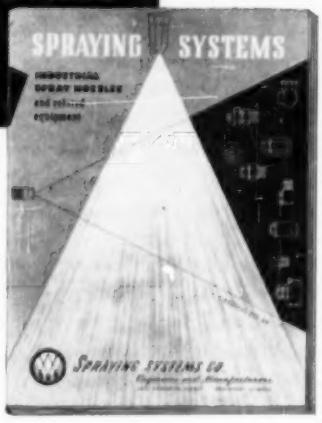

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people
(management & technology)

(Continued from page 122)

Clarence A. Stiegman is named technical director and **J. Howard Brunn** general manager, Niagara research and development, at Hooker Electrochemical Co., Niagara Falls, N. Y. **Johannes H. Brunn,** director of research and development, has resigned. **David S. Rosenberg** has been appointed manager of process improvement and development, heading a new group formed at Hooker to study and improve existing chemical processes as an arm of research and development. Also at Hooker, **James E. Dillman** is the new technical supervisor, process study; **Elliott P. Doane,** supervisor, pilot plant; and **Benjamin W. Hancock** is technical foreman of Area 4.

Stiegman

Rosenberg

Humphrey J. Elliott, Jr., has rejoined the staff of the Atlantic Research Corporation, Alexandria, Virginia. He will be with the Project Engineering Group.

Wesley B. Argo, St. Louis, has been appointed a research group leader of Monsanto Chemical Company's Organic Chemicals Division after a six year stint in the research section. **Jack W. Thompson** has been transferred to St. Louis as a supervising engineer in the project section, Engineering Department, of the Inorganic Chemicals Division. **Arthur C. Ryder** has joined the engineering section, Production Department, of Monsanto's Plastics Division at Santa Clara. **Lawrence E. Stout, Jr.,** has joined the chemical and mechanical section in the engineering department, Research and Engineering Division, at St. Louis. **Joseph F. Galluzzo** has become a member of the technical services department at the Wm. G. Krumrich Plant, Monsanto, Ill. Newly-appointed assistant plant manager **Thomas S. Hostetter** will be at Monsanto's Inorganic Chemicals Division plant at El Dorado, Ark. The construction section of the company's Inorganic Chemicals Division, engineering department at St. Louis, loses its assistant manager **William J. Burkett,** who is to become maintenance supervisor at the Trenton, Michigan plant.

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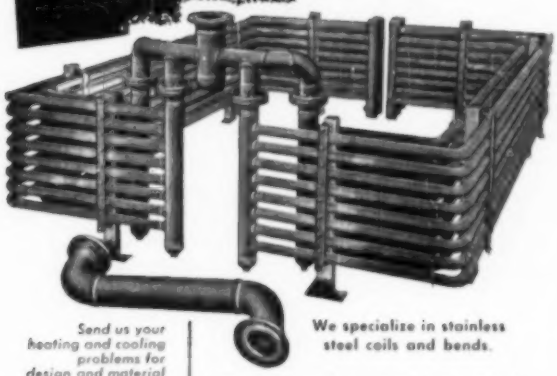

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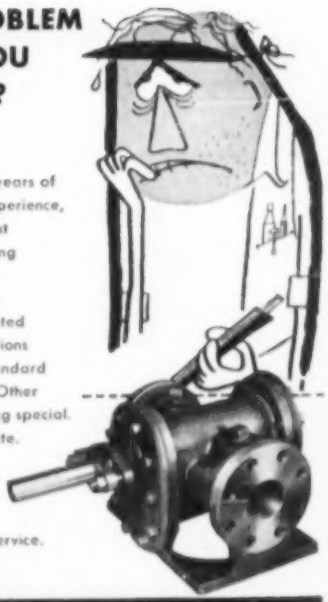

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Every so often an unprecedented demand for a particular issue, or an unexpected influx of new subscribers and members puts the editor in the embarrassing position of running out of copies of Chemical Engineering Progress. This has happened several times in our short history and if members have copies of any of the following issues, we would be glad to purchase them.

The issues which we need and for which we will pay 75 cents each are: January, 1949; October, 1952; January, 1954; February, 1955; January, 1956; January, April, 1957.

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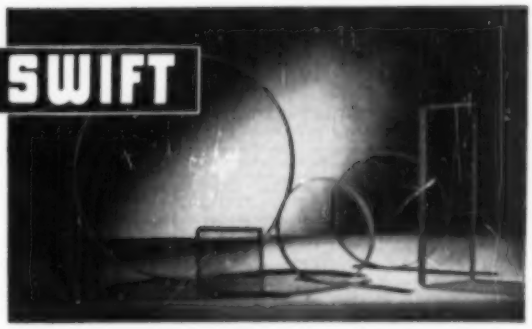

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MANUFACTURING EXECUTIVE.—B.S.Ch.E. 1947. Business administration minor. Experience as superintendent, plant manager in process industry. Fortitude in handling labor and production problems. Naval administration and command. Will travel. Age, 35. Family. Minimum salary, $12,000. Box 3-12.

PROCESS DEVELOPMENT — RESEARCH, CHEMICAL ENGINEER.—Ph.D., age 35. Inorganic, also plastics. Fertilizer development, economic evaluation, bench and pilot plant investigations leading to plant operation. Seek challenging, responsible assignments involving chemical processes and products. Box 4-12.

CHEMICAL ENGINEER.—B.S.Ch.E. 1953, age 26, married. Three years experience developing high energy fuel processes. Desire professional position in process design or development. Box 5-12.

HAVE SLIDE RULE, WILL TRAVEL.—B.M.E., M.S.Ch.E., age 29, three years industrial experience. Fluent Spanish. Adequate knowledge of four foreign languages. Desire position in activity where technical knowledge, personality and languages can be used to advantage. Box 6-12.

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CHEMICAL ENGINEER—32, family, B.S.Ch.E. 1955. Two years project engineering liquid metals, "Q" clearance, tech reports, mechanical aptitude, high interest organic processing and unit operations. Want organic chemical production or development. Prefer Northern U.S.A., small town. Box 9-12.

CHEMICAL ENGINEER—B.S.Ch.E., 7½ years diversified sales, development, design, and operational experience. Desire employment at supervisory level with administrative responsibilities. Box 10-12.

PROJECT-PROCESS ENGINEER. Proven ability in the design of chemical and petrochemical plants. Able to make complete process calculations and coordinate other design phases from process inception to start-up. Age 28. Tau Beta Pi. Fluent French and German. Desire position with responsibility New York City or metropolitan New Jersey. Present salary $800 month. Only replies completely outlining duties will be considered. Box 11-12.

CHEMICAL ENGINEER—B.S.Ch.E. 1953. Age, 26, family, veteran, graduate study. Presently employed in sales. Desire Research and Development position in Delaware Valley. Box 12-12.

PROCESS ENGINEER—B.S.Ch.E. 1950, Reg. P.E., over 7 years varied oil refinery experience, successful background in economics, design, pilot work, operations supervision, reports, estimates. Desire responsible supervisory position utilizing experience and ability. Box 14-12.

CHEMICAL ENGINEER—M.S.Ch.E. Two years production experience pharmaceuticals and solvent refining; five years Ordnance engineering; two years instructing undergraduate thermodynamics. Background operations research, digital computing. Desire position advancement potential. Salary $11,000. N.Y.-N.J. area. Box 15-12.

WILLING TO TAKE CALCULATED RISK to obtain good chemical engineer? Non-citizen, B.S., M.S., M.I.T. 26, now residing Manila, Philippines; desire job offer to facilitate immigration and return to U.S. Had been in U.S. over six years. Willing to travel at own expense. W. S. FONG, P.O. Box 1617, Manila, Philippines.

CHEMICAL ENGINEER—B.Ch.E. 12 years experience in chemical process development through pilot plant, where required, in both carbohydrate and fertilizer fields including process evaluation and design; resolution of the idea into an operating economical process. Box 16-12.

PROJECT MANAGER—P.E., B.S.Ch.E. 1948, seeking position as Chief Engineer of medium sized company or executive assistant to plant manager or equivalent. 9½ years experience in plant design, economic evaluation, construction, start-up and maintenance of operations involving high polymer polymerization and related processes. Presently managing multi-million dollar project. Box 17-12.

CHEMICAL ENGINEER—B.S.Ch.E., age 33, family. Seven years experience in process and equipment design, plant and project engineering, maintenance, estimating and purchasing. Also radioactive chemical separations experience and "Q" clearance. Desire responsible position West Coast. Box 18-12.

CHEMICAL ENGINEER—B.S.Ch.E. 1951, Family, six years experience including refinery process control, design and economics, overall refinery coordination, and recent experience stored program computers and Operations Research methods. Member Tau Beta Pi, Sigma Tau, registered professional engineer. Desire position entailing responsibility and advancement opportunities. Preferable location Latin America. Fluent Spanish. U. S. citizen, previous overseas experience. Box 22-12.

(Continued on page 128)

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Operations Research is a young science, earning recognition rapidly as a significant aid to decision-making. It employs the services of mathematicians, physicists, economists, engineers, political scientists, psychologists, and others working on teams to synthesize all phases of a problem.

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SITUATIONS WANTED

(Continued from page 127)

PRODUCTION MANAGEMENT ENGINEERING—M.Ch.E. Fifteen years' experience in chemical food processing and aerosol packaging plants. Plant manager, process engineer, process evaluation and development, production supervision. Seeking responsible position in production management. Present salary $11,000. Box 23-12.

ENGINEERING AND FINANCE—Senior chemical engineer and registered stock broker. Desire position in finance leading to high management position. Experienced in project engineering, purchasing, production and finance. Know nuclear, chemical and pharmaceutical industries. Age 39. "Q" clearance. Box 24-12.

CHEMICAL ENGINEER—Age 29. Seven years' industrial experience in research, pilot plant supervision and plant supervision. Extensive experience with extraction metallurgy. Desire position in process development. Midwestern or southern location. Box 25-12.

Nonmember

CHEMICAL ENGINEER—INDUSTRIAL ENGINEER—M.S. both fields; completion all course work ScD. 11 years diversified experience technical-economic evaluations, consulting, market research, sales engineering, product/process studies. Desire career position. Sigma Xi. Age 36, family. Box 1-12.

CLASSIFIED SECTION RATES

Advertisements in the Classified Section are payable in advance at 24¢ a word (effective January 1958), with a minimum of four lines accepted. Box number counts as two words. Advertisements average about six words a line. Members of the American Institute of Chemical Engineers in good standing are allowed one six-line Situation Wanted insertion (about 36 words) free of charge a year. Members may enter more than one insertion at half rates. Prospective employers and employees in using the Classified Section agree that all communications will be acknowledged, the service is made available on that condition. Answers to advertisements should be addressed to the box number, Classified Section, Chemical Engineering Progress, 25 West 45th Street, New York 36, N. Y. Telephone COlumbus 5-7330. Advertisements for this section should be in the editorial offices the 10th of the month preceding publication.

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people
(management & technology)

(Continued from page 124)

Thomas E. Kopp becomes a member of the production department of Monsanto's Inorganic Division at Trenton, Michigan; **Roy G. Moore** is now a member of the production department of the Carondelet Plant of Monsanto's Inorganic Division at St. Louis; **Sidney Kleinberg** becomes a member of the research department of Monsanto's Inorganic Division at St. Louis as has chemical engineer **James E. Schoolmeester.**

Fred W. Obermann has become a member of the technical services department of Monsanto's Organic Chemicals Division at the John F. Queeny Plant, St. Louis.

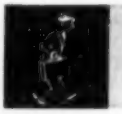
Robert O. Nellums has been promoted to assistant director of research at Monsanto Chemical Company's Organic Chemicals Division.

New process engineer with Badger Manufacturing Company, Cambridge, Mass., is **James J. Graham.**

D. B. Benedict has been elected a vice-president of Union Carbide Corporation. He will be responsible for the corporation's chemicals and plastics activities. Also announced were the appointments of **E. E. Fogle** as president of Union Carbide Chemicals Company and of **H. D. Kinsey** as president of the newly-formed Union Carbide Olefins Company.

Appointment of **Harold H. Radke** as a development program analyst for B. F. Goodrich Chemical Company has been announced. **A. L. Schultz** has been named manager of rubber and rubber chemicals development at Goodrich's development center at Avon Lake, Ohio. **Arne Melby,** plant manager of Goodrich Chemical's Niagara Falls, N.Y. plant, has been assigned to supervise construction of a new synthetic rubber plant in Japan to be built by Japanese Geon, Ltd. New plant manager at Niagara Falls is **Philip H. Lawrence.**

John F. Ryan has been named an acting section head in the Chemicals Development Division of Esso Research and Engineering Company, Linden, N. J.



people
(marketing)

The Electrode Division of Great Lakes Carbon Corporation has named **Michael A. Wrotniak, Jr.,** foreign sales manager of the division. A graduate of the Georgetown University School of Foreign Service, Mr. Wrotniak will promote and coordinate the sale of graphite electrodes, anodes, mold stock and specialties in all foreign markets, with the exception of Canada.

Wrotniak

Ernest S. Robson has been appointed district sales manager for Monsanto Chemical Company's Organic Chemicals Division at New York.

The newly-created position of sales manager of Jefferson Chemical Company, Inc., has been filled by **J. R. Carlson.** Simultaneous announcement was made of the appointment of **P. R. Monaghan** as regional manager of the eastern region.

James M. Carmen has been appointed staff assistant to the director of steel sales for the A. M. Byers Company.

Forrest M. Luckett, Chicago district sales manager for Monsanto's Organic Chemicals Division since 1951, has been appointed to the newly created position of central regional sales manager for the Organic Chemicals Division at Chicago.

New assistant director of sales of plasticizers, resin materials, and paper chemicals product groups for Monsanto is **H. James Lawler;** he will be with the Organic Chemicals Division at St. Louis. Also at St. Louis, **Herbert S. Parham** assumes responsibility for the fine chemicals, agricultural chemicals, petroleum additives and intermediates product groups and **James Starrett, Jr.,** will be new sales manager of agricultural chemicals. Filling the newly-created position of personnel and training manager at St. Louis will be **Armin L. Klemm.**

Necrology

George W. Merck, 63, chairman of the board of directors of Merck & Co., of a cerebral hemorrhage November 9.

Charles Henry Snow, 94, dean emeritus of the College of Engineering at New York University, on October 28 after a long illness.

INDEX OF ADVERTISERS

	Page
Abbe, Inc., Paul O.	104
Ace Glass Incorporated	96
Adsco Div., Yuba Consolidated Industries, Inc.	25
Aerofin Corporation	88
Air Products, Inc.	29
Aldrich Pump Co., The	38
Allis-Chalmers	15, 77
American Air Liquide	40
American Hard Rubber Co.	36
Argonne National Laboratory	39
Badger Mfg. Co.	79
Barnstead Still & Demineralizer Co.	100
Bartlett-Snow Co., The C. O.	109
Bethlehem Foundry & Machine Co.	53
Black, Sivalls & Bryson, Inc.	10
Bowen Engineering, Inc.	129
Brookfield Engineering Labs. Inc.	93
Brown Boveri Corp.	71
California Steel Prods. Div.	87
Cambridge Wire Cloth Co.	76
Capitol Products Corporation	18
Carborundum Co., Refractories Div.	33
Carlson, Inc., G. O.	9
Catalytic Construction Co.	69
Centrico, Inc.	112
Chempump Corporation	31
Chicago Bridge & Iron Co.	49
Cole Mfg. Co., R. D.	122
Croll-Reynolds Co., Inc.	61
Crucible Steel Co. of America	91
Curtiss-Wright Corp.	30
Davis Engineering Corp.	108
Dean Thermo-Panel Coil Div., Dean Products, Inc.	129
DeZurik Corporation	85
Dorr-Oliver Incorporated	65
Downingtown Iron Works, Inc.	44
Duraloy Company, The	120
Durametallic Corp.	124
Eaton-Dikeman Company	86
Eimco Corporation	81
Elliott Company	72
Engineers & Fabricators, Inc.	37
Fairbanks, Morse & Co.	105
Fansteel Metallurgical Corp.	80
Fletcher Works, Inc.	95
Fluor Products Co., Div. of The Fluor Corp., Ltd.	46
Foxboro Company, The	11
Gas Atmospheres, Inc.	97
General American Transportation Corp., Turbo Mixer Div.	47
General Electric Company	26-27
Girdler Company, Votator Div.	73
Graham Mfg. Co., Inc.	50
Great Lakes Carbon Corp.	
Dicalite Div.	123
Electrode Div.	13
Gump Co., B. F.	3
Hayes & Stolz Industrial Mfg. Co., Inc.	117
Ingersoll-Rand	35, 43
Kahn & Company, Inc.	107
Kellogg Co., M. W., The	67
Knox Porcelain Corp.	124
Lapp Insulator Co. Inc.	7
Linde Company, Div. of Union Carbide Corp.	41, 83
Manning & Lewis Engineering Co.	106
Metallic Gasket Co.	101
Midland Industrial Finishes Co.	94
Misco Fabricators, Inc.	101
Mixing Equipment Co., Inc.	Outside Back Cover
National Carbon Co., Div. of Union Carbide Corp.	99
National Engineering Co.	12
Niagara Blower Co.	78
Parsons Company, The Ralph M.	Inside Back Cover
Patterson-Kelley Co., Inc.	59
Pfaudler Co., The	89
Philadelphia Gear Works, Inc.	34
Powell Co., The William	16
Prat-Daniel Corp.	54
Pritchard & Co., J. F.	121
Proctor & Schwartz, Inc.	63
Read Standard Div.	18
Rempe Company	125
Roots-Connersville Blower Div. of Dresser Industries, Inc.	51
Sargent's Sons Corp., C. G.	98
Schutte & Koerting Co.	125
Sharples Corp., The	17
Simpson Mix-Muller Div.	12
Southwestern Engineering Co.	75
Sperry & Co., D. R.	70
Spraying Systems Co.	122
Sturtevant Mill Co.	119
Struthers Wells Corporation	6
Swift Glass Div., Swift Lubricator Co., Inc.	125
Taylor & Co., W. A.	106
Texas Gulf Sulphur Co.	103
Thayer Scale Corp.	42
Thermal American Fused Quartz Co., Inc.	107
Thermco Electric Co., Inc.	100
Thermco Laboratories	116
Turbo-Mixer Div., General American Transp. Corp.	47
Union Carbide Corp.	
Linde Co. Div.	41, 83
National Carbon Co.	99
U. S. Gasket Co., Plastics Div. of The Garlock Packing Co.	32
U. S. Industrial Chemicals Company, Division of National Distillers & Chemical Corporation	23, 24
U. S. Stoneware	564
Vanton Pump & Equipment Corp. Div. of Cooper Alloy Corp.	116
Virginia Gear & Machine Corp.	34
Vulcan-Cincinnati, Inc.	Inside Front Cover
Wallace & Tiernan, Inc.	84
Wyssmont Company, Inc.	92
York Co., Inc., Otto H.	4
Yuba Consolidated Industries, Inc.	25, 87
Yuba Heat Transfer Div.	87

C.E.P. Advertising Offices

New York 36—Lansing T. Dupree, Adv. Mgr.; John M. Gaede, Asst. Adv. Mgr.; Paul A. Jolcuvar, Dist. Mgr.; Donald J. Stroop, Dist. Mgr.; Hale H. Carey, Dist. Mgr.; 25 W. 45th St., Columbus 5-7330.

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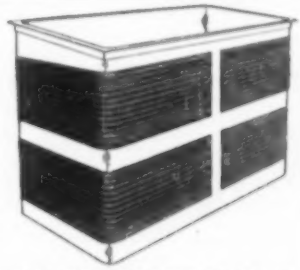

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news and notes of A.I.Ch.E.

An Accounting of Stewardship . . . As in other years, I am making this final column of 1957 a report to the members of the year's highlights . . . what events have occurred of importance to the Institute from my viewpoint & how goes it with A.I.Ch.E.? . . . If we followed the practice of the Chinese, in giving names to the years, we in A.I.Ch.E. would probably call 1957 the year of I.B.M. . . . For some time it has been apparent that among the great needs in headquarters are the answers to who are you & what do you do? . . . After about two years of investigation a **punched-card** system containing easily retrievable information about every member was installed . . . Consequently, in March of this year all members & all subscribers received an extensive questionnaire . . . The office was a snowstorm of replies & many wearisome days were spent in deciphering, coding & key punching . . . We are fortunate to be staffed by a group of devoted people who work many, many hours overtime in order that you, the members, may be served . . . The **directory,** which was issued in October to members on request, was the first major product of the I.B.M. system . . . The punched cards represent, we in headquarters think, a giant step forward in efficient service. . . . Also during this year preliminary planning has gone forward for the **Fiftieth Anniversary** next June . . . During the week of June 22 chemical engineers from all over the world will be at Philadelphia to celebrate the founding of A.I.Ch.E. . . . **The United Engineering Center** was another major project that took innumerable hours of staff time . . . A.I.Ch.E. accepted the invitation to become a member of United Engineering Trustees, which is building the new home for the engineering societies . . . During the year Council decided to turn over the **Nuclear Exposition**, which A.I.Ch.E. had sponsored & owned since its inception several years ago, to the Nuclear Congress, so that any income from the exposition might be used to defer the expenses of the Congress itself . . . Sharing with us will be the four other founder societies & the American Nuclear Society . . . A.I.Ch.E. is managing the Nuclear Congress that will take place in Chicago next year, an effort that at present is pretty well absorbing the services of a new assistant secretary who came to A.I.Ch.E. in January, 1957, Joel Henry . . . . **Financially,** while our income is increasing so are our expenses & the number of things we are attempting to do . . . We are trying to bring bigger & better publications to all our members . . . Our publications have been the main source of income for A.I.Ch.E. since 1952 . . . the proportion is growing constantly . . . much of the income which we receive from publications, however, is plowed back in order to further our growth . . . We are building a staff of editors that will be able to meet the current challenge for vital reportorial leadership in the chemical engineering field . . . we are building a sales staff that we feel will enlarge A.I.Ch.E.'s share of the market in order that as the spokesman for the profession of chemical engineering the Institute may continue to serve the members in the way it should. . . **Council** is constantly faced with the threat of inadequate financing & it is a tribute to the courage of Council members that they are willing to continue to expand in the faith that chemical engineering is not stagnant but is growing . . . **The committees of the Institute** have continued to be a great source of inspiration for me in my work as Secretary . . . The hours that men spend in forwarding the objectives of A.I.Ch.E. are awesome & gratifying & the contribution that our industrial companies make . . . in supporting committee work, in helping Local Sections to put on meetings, both locally & nationally, in sending men to committee functions & to meetings . . . is remarkable. . . . One of the men who served most staunchly in this work was **George Granger Brown,** whose death on August 26 was a severe loss to all chemical engineers . . . G.G. was our Treasurer, as everyone knows, a most distinguished man, & to me a close friend. . . . **As a personal note**, may I thank the members for their continued support . . . I look forward to the challenge that the Institute offers to me & to the chemical engineers of the nation. . . . May I wish everyone a Merry Christmas & a most prosperous New Year. . . . See you, each & every one, in Philadelphia next June.

F.J.V.A.

MEMO

THE RALPH M. PARSONS COMPANY

TO: The Chemical Process Industries

FROM: Fred

SUBJECT: TRUST and CONFIDENCE

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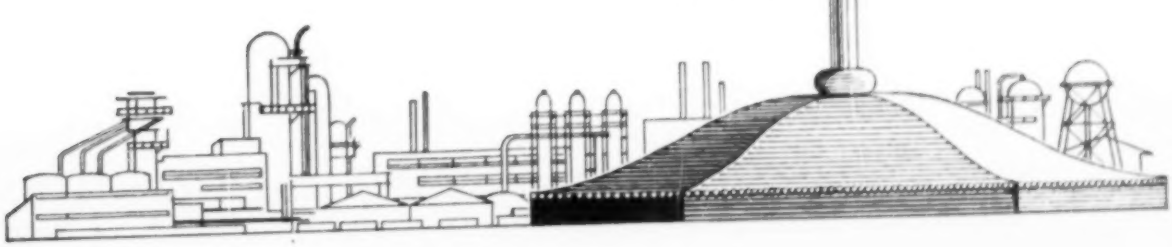
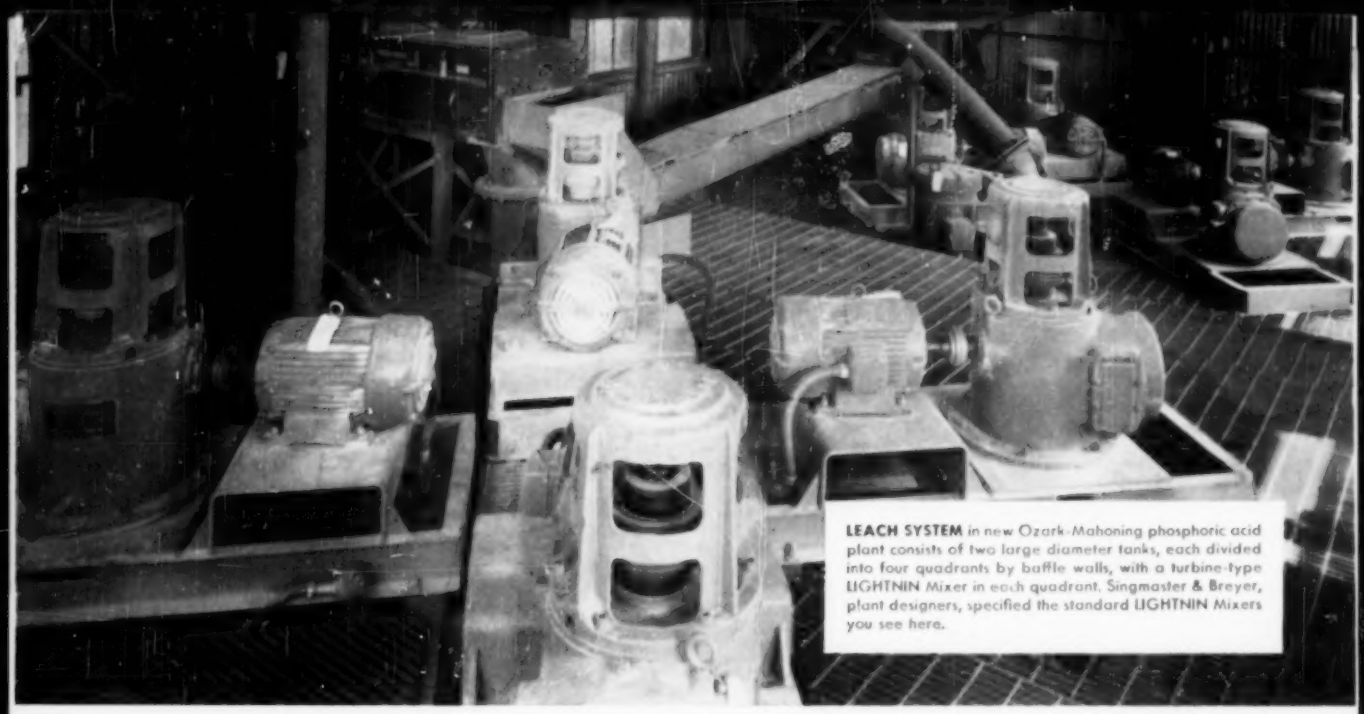
PARSONS

means Mutual Trust





LEACH SYSTEM in new Ozark-Mahoning phosphoric acid plant consists of two large diameter tanks, each divided into four quadrants by baffle walls, with a turbine-type LIGHTNIN Mixer in each quadrant. Singmaster & Breyer, plant designers, specified the standard LIGHTNIN Mixers you see here.

New acid process gives **95% yield** *with good mixing in leach tanks*

More often than you might think, *good mixing of fluids* can make the difference between "just average" and superior process results.

That's one reason why LIGHTNIN Mixers were specified for this new wet-process phosphoric acid plant at Ozark-Mahoning Company, Tulsa, Okla. Singmaster & Breyer, New York engineering firm, did the process and equipment design for Ozark-Mahoning Company.

High yield—low cost

Utilizing the Belgian Prayon process, relatively new to this country, the plant consistently yields better than 95% of acid containing 30% P_2O_5. It produces a 32% product from sulfuric acid as weak as 55%.

Leaching temperature is 15-20 degrees cooler than conventional processes—easing the corrosion problem and permitting the use of less costly materials of construction.

The new plant has run without a hitch since the day Ozark-Mahoning operating management pushed the button.

How mixers help

Good mixing does its job in the leach system, where finely ground phosphate rock is slurried with recycled phosphoric acid, then reacted with sulfuric acid to precipitate gypsum.

A LIGHTNIN Mixer in each of eight leach-tank compartments provides the exact balance of fluid flow and turbulence needed for intimate acid contacting and highest extraction values.

The LIGHTNINS also provide complete uniformity and immediate dispersion of reactants, resulting in the growth of large, easily filtered gypsum crystals.

On *your* next project, why take chances on fluid mixing when you can be *sure?* With LIGHTNIN Mixers, you get the security of knowing there's a mixer to match your requirements *exactly*—with replacement parts always quickly available if you ever need them.

Predictable results

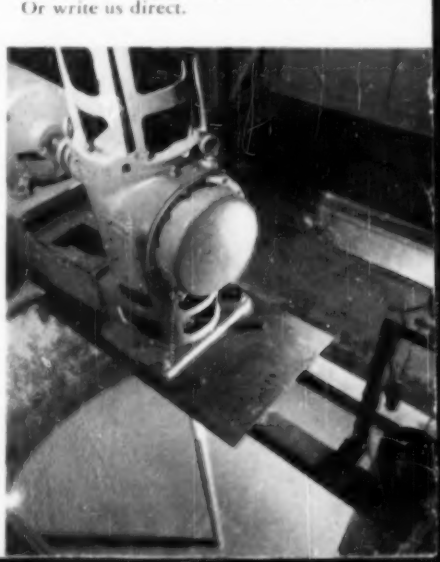
You're sure about *results*, too—because your LIGHTNINS are selected on the basis of application and test data unique in industry. Many thousands of pilot runs, plus scientific methods of scale-up, insure predictable mixing results that are unconditionally guaranteed.

For quick, competent help in getting a new process started right, or in making an old process more efficient, call your LIGHTNIN Mixer representative. He's listed in Chemical Engineering Catalog. Or write us direct.

Lightnin Mixers

MIXCO fluid mixing specialists

YOU CAN HANDLE any fluid mixing job, in tanks of any size or shape, with LIGHTNIN Mixers. Results are fully predictable, unconditionally guaranteed.



FOR LATEST MIXING INFORMATION and full description of LIGHTNIN Mixers, send for these helpful bulletins:

- ☐ Top or bottom entering, turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering, propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- ☐ Data sheet for figuring mixer requirements (B-107)

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 199-n Mt. Read Blvd., Rochester 11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 10, Ont.